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## COVER SHEET

### Access 5 Project Deliverable

**Deliverable Number:** WX001-Rev2

**Title:** Weather Requirements and Procedures

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**Abstract:**

This cover sheet is for version 2 of the weather requirements document along with Appendix A. The purpose of the requirements document was to identify and to list the weather functional requirements needed to achieve the Access 5 vision of “operating High Altitude, Long Endurance (HALE) Unmanned Aircraft Systems (UAS) routinely, safely, and reliably in the National Airspace System (NAS) for Step 1.” A discussion of the Federal Aviation Administration (FAA) references and related policies, procedures, and standards is provided as basis for the recommendations supported within this document. Additional procedures and reference documentation related to weather functional requirements is also provided for background. The functional requirements and related information are to be proposed to the FAA and various standards organizations for consideration and approval. The appendix was designed to show that sources of flight weather information are readily available to UAS pilots conducting missions in the NAS. All weather information for this presentation was obtained from the public internet.

**Status:**

SEIT-Approved

**Limitations on use:**

This document represents thoughts and ideas of the Weather Awareness work package team. It has not been reviewed or approved as an Access 5 project position on this subject. In addition to SEIT review and comment, the information also needs substantiation through simulation/flight demonstrations. Furthermore, this document is an interim deliverable. It represents the project position on Weather Awareness functions and performance requirements limited to enroute operations above FL430. Operations below FL430 and terminal operations have not been addressed in this document.



**Weather Requirements and Procedures**  
**(Update for FY05)**  
**For**  
**STEP 1**  
**High Altitude Long Endurance (HALE)**  
**Unmanned Aircraft System (UAS)**  
**Flight Operations in the National Air Space (NAS)**  
**By**  
**WP09 Weather Work Package**

*The following document was prepared by a collaborative team through the noted work package. This was a funded effort under the Access 5 Project.*



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## EXECUTIVE SUMMARY

The purpose of this document is to identify and to list the weather functional requirements needed to achieve the Access 5 vision of “*operating High Altitude, Long Endurance (HALE) Unmanned Aircraft Systems (UAS) routinely, safely, and reliably in the National Airspace System (NAS) for Step 1.*” A discussion of the Federal Aviation Administration (FAA) references and related policies, procedures, and standards is also included. Additional procedures and reference documentation related to weather functional requirements is also provided for background. The functional requirements and related information are to be proposed to the FAA and various standards organizations for consideration and approval.

Additional information contained in this document relates to the availability and the limitations of weather data and products required for support to Step 1 operations. The need for routine weather information, both current and forecast, at Step 1 altitudes which are above FL430 is not new. Since the highest current use of the NAS occurs at altitudes below FL430, the availability of forecast weather data and products is limited above that flight level. Few forecast weather data and products are currently produced by the National Weather Service (NWS) National Meteorological Center (NMC) at or above FL450. This document identifies some of the limitations with obtaining weather information for the Step 1 mission profile.

**Access 5 High Altitude Long Endurance (HALE)  
Unmanned Aircraft System (UAS)  
Weather Requirements and Procedures for STEP 1 Flight Operations**

1. General. The Access 5 HALE UAS requires weather awareness requirements and procedures to perform Access 5 STEP 1 flight operations. All Access 5 STEP 1 flight operations begin when the UAS enters the airspace at altitudes at or above FL430. The Access 5 weather work package is responsible for producing requirements and procedures involving weather for STEP 1 UAS flight operations. This document provides weather requirements and procedures to be considered for application for Access 5 STEP 1 flight operations.
2. Background. The need for routine weather information, both current and forecast, at altitudes above FL430 is not new. However, based on the research completed for this requirements investigation, commercially available weather information for operating altitudes of FL450 and higher is limited. The limitations discovered during the investigation detailing the weather limiting factors for Access 5 HALE UAS STEP 1 operations are provided below.
  - a. Limitations on forecast weather data and products at or above FL450. Since the highest current use of the NAS occurs at altitudes below FL430, the use of forecast weather data and products is limited above that flight level. In addition, based on the investigation results at this time the National Weather Service (NWS) National Meteorological Center (NMC) has no requirement to produce forecast weather data and products above FL550, or atmospheric pressure levels above 100 millibars (mb) or hectopascals (hPa). Based on this investigation the limitations listed below exist for forecast weather data and products.
    - i. Forecast wind and temperature data are not normally available for FL450 and FL530, but are available on request/reply to users via AFSS/FSS.
    - ii. NOTE: There are specific flight level winds which NOAA, NWS, and NMC produce products for on a normal schedule. Data for FL420 through FL480 must be specially requested and are normally derived from the flight level closest to actual standard NWS forecast level.
    - iii. Forecast data and products for wind, temperature, and flight hazard (turbulence, and icing) information and products at operating altitudes at or above FL530. Based on the investigation completed this year, it is unclear whether or not the NWS produces flight hazard forecasts at or above FL530. The references reviewed do not list any data or products above FL530.
    - iv. NOTE: A high-level significant weather prognostic chart is produced for the entire layer from FL240 to FL600. However, these products provide average weather conditions for the entire FL240-to-FL600 layer, but do not provide information at specific altitudes in this layer.
  - b. Observed weather data and products at or above FL430. The NWS produces observational data for altitudes below, at, and above FL430. These observations are

primarily taken from the NWS rawinsonde network. Rawinsonde observations include temperature, wind, humidity, and several other meteorological parameters. The rawinsonde observations are taken at specified levels from station ground level up to approximately 100,000 feet. These data are available via the internet and specify data for designated rawinsonde sites located across the U.S.

3. STEP 1 Limitations. Since the Access 5 HALE UAS program is phased into 4 steps there are specific weather work package objectives to be addressed for each of these steps. The STEP 1 objectives are limited to weather support requirements for flight operations at or above FL430. This implies weather issues will be limited to addressing the following operational areas:
  - a. Safety of flight and Step 1 weather awareness at or above FL430
  - b. Maneuvering and routing at or above FL430
  - c. Mission planning at or above FL430
  - d. Solar Environmental Events affecting flight at or above FL430
  - e. Contingency Management for Solar Environmental Events affecting flight at or above FL430.
  - f. Weather requirements below FL430 are not part of, nor the responsibility of, the Access 5 STEP 1 program effort.
4. STEP 1 Assumptions. The requirements listed in this document provide a starting point for the evaluation of STEP 1 weather support and procedures. These requirements were produced using the following set of assumptions:
  - a. Unless specifically addressed under limiting factors (para. 5), weather data and products required for initial STEP 1 flight operations are available via the highest possible direct or internet communications connection speed from existing public or private Qualified Internet Commercial Provider (QICP) sources.
  - b. UAS pilot organizations supporting Access 5 flight operations have access to weather sources required for initial STEP 1 flight operations.
  - c. UAS pilots are required to satisfy the same FAA en route wind weather briefing information requirements levied on other non-UAS pilots.
  - d. The Access 5 Policy IPT will address with the appropriate agencies any limiting factors identified by this work package in the area of STEP 1 weather data and products.
  - e. The UAS pilot has as good or better access to flight weather information than pilots of manned aircraft.
5. Step 1 Weather Functional Requirements. The following weather functional requirements apply to Access 5 HALE UAS Step 1 operations. These requirements are extracted from the Functional Requirements Document for HALE UAS Operations in the NAS, Step 1, Version 2, dated September 2005.

### **5.4.3 AVOID HAZARDOUS WEATHER**

***The UAS shall be able to avoid hazardous weather while flying in the NAS.*** Hazardous weather is defined as any atmospheric or space environment phenomena that could be

detrimental to the UAS mission. Hazardous aviation weather for the purposes of Step 1 typically includes thunderstorms, icing conditions, turbulence, or massive solar ejections. However, this may vary based on the structural characteristics of the UA being flown. It is important to note that the primary need for the UAS avoiding hazardous weather is to prevent the UA from harming people or property, not for self preservation of the UA.

#### **5.4.3.1 Maintain Weather Awareness**

*The UAS Weather Awareness System shall maintain awareness of hazardous weather along the entire route of flight.* The UAS should be able to routinely access pertinent aviation weather information to include atmospheric and space weather data. This requirement ensures the UAS pilot has access to the necessary weather information resources such as ATC and/or packaged weather products, throughout the entire route of the flight.

##### **5.4.3.1.1 Gather Weather Information**

*The UAS Weather Awareness System shall gather all necessary weather information for the entire route of flight.* This information should be gathered for the altitude at which the UAS will be operating as well as the area below the UAS in case descent through the lower airspace is required. It is assumed that the UAS pilot is part of the UAS Weather Awareness System.

###### **5.4.3.1.1.1 Request weather information (HSI F8b)**

*The UAS Human System Interface shall enable the pilot to request weather specific to a current or future flight plan.*

###### **5.4.3.1.1.2 Convey weather information to the UAS Pilot (HSI F8a)**

*The UAS Human System Interface shall convey weather information to the pilot.*

##### **5.4.3.1.2 Evaluate Potential for Weather Conflicts**

*The UAS Weather Awareness System shall evaluate the potential for flying into hazardous weather situations.* This requirement enables the UAS pilot to plan for hazardous weather along the route of flight utilizing all available weather resources.

#### **5.4.3.2 Coordinate Weather Avoidance Maneuver**

The UAS Weather Awareness System shall coordinate with ATC the appropriate avoidance maneuver that prevents the UA from flying through the hazardous weather. The UA will always be flying under Instrument Flight Rules and, therefore must coordinate any deviation of the current flight path with ATC.

#### **5.4.3.3 Command Weather Avoidance Maneuver**

*The UAS Weather Awareness System shall be capable of commanding an appropriate*

***maneuver to avoid the hazardous weather.*** It is assumed that the UAS pilot, as part of the UAS Weather Awareness System, will initiate the maneuver since autonomous maneuvers are outside the scope of Step 1. The commanded maneuver can include initiating a new maneuver, continuing an ongoing maneuver, or terminating an avoidance maneuver if hazardous weather no longer exists.

#### **5.4.3.3.1 Control the Weather Awareness System (HSI F8c)**

***The UAS Human System Interface shall enable the pilot to control the Weather Awareness System.*** The pilot must have the ability to configure the Weather Awareness System settings as well as initiate, modify, or discontinue and avoidance maneuver.

6. ***Detailed weather requirements discussion.*** The following information provides background detail on the Step 1 Weather Functional Requirements. In addition, a separate section is included to highlight key procedural considerations related to the functional requirements.
  - a. ***STEP 1 Requirements.*** The process of identifying weather requirements for Access 5 HALE UAS flight operations will evolve over the life of the Access 5 program. This document provides an initial set of support requirements for areas expected to be part of STEP 1 flight operations. As the initial and follow-on simulation and flight test events take place and weather impacts are better known, this list of requirements will be refined and updated. These updates and refinements will lead to a set of requirements that reflect a more broad operational scope of weather support required for STEP 1 flight operations. The initial requirements are listed below.
    - i. UAS pilots are required to have the appropriate pilot knowledge accessible to them with regard to Air Traffic order 7110.10R, Flight Services, with specific reference to Chapter 9, FAA Weather Services.

NOTE: FAA document, Advisory Circular (AC) 00-45E, December 1999 (revised), Aviation Weather Services, is the Air Traffic publication weather services reference in publication 7110.10R for detailed information weather services provided to FAA certified aircraft.
    - ii. UAS pilots are required to have the appropriate pilot knowledge accessible to them with regard to Air Traffic Order 7210.3T, Facility Operation and Administration, with specific reference to Part 4, Chapter 14, Aviation Meteorological Services and Equipment.
    - iii. UAS aircraft pilots can access the information on ATC Service A circuits, which may include but is not limited to, the Hazardous In-flight Weather Advisory Service (HIWAS), to receive updated weather information while operating UAS aircraft.
    - iv. UAS aircraft pilots require the following atmospheric flight weather briefing information for weather awareness, mission planning, safety of flight,

contingency management and scheduled operations at or above FL430 for the entire route and duration of flight:

1. Pilot weather briefing information on current and forecast en route winds at the expected operating altitude at or above FL430
2. Pilot weather briefing information on current and forecast en route temperatures along the route at the expected operating altitude
3. Pilot weather briefing information on forecast flight hazards (turbulence or icing) of any intensity en route at the expected operating altitude at or above FL430
4. Pilot weather briefing information on forecast areas of en route thunderstorms.
5. Pilot considers all weather awareness information as appropriate to the mission, and proceeds per approval of the FAA during flight
6. Pilot has access to all QICP websites depicting appropriate tropospheric weather data useful to flight.
7. Pilot shall gather hazardous atmospheric weather information and take the appropriate actions to complete UAS mission planning preparations prior to flight.
8. Pilot shall access and update mission planning information as necessary from all QICP sources to ensure appropriate route changes are completed to avoid new or developing hazardous tropospheric weather conditions.
9. When a contingency occurs, the pilot shall access and update contingency management information as necessary from all QICP sources to ensure appropriate route changes are completed to avoid new or developing hazardous weather conditions.
10. During conditions requiring emergency landing at a planned or unplanned divert location, the pilot shall access weather information required to make the appropriate landing preparations.
11. The UAS shall be able to avoid hazardous weather in the troposphere by maneuvering the UA in accordance with weather information provided by the HSI interface or ATC advisories. This requirement ensures the UAS is equipped with the capability for routine access to real time aviation weather information while airborne.

NOTE: Forecast information at altitudes FL450 and FL530 is available via special request (Reference: AT publication 7110.10R, paragraph 9-4-2).

- v. UAS aircraft pilots require the following radio communication and navigation flight weather briefing information for weather awareness, mission planning, safety of flight, contingency management and scheduled operations at or above FL430:
  1. Pilot weather briefing on flight communications and navigation impacts due to solar environmental events/activity recent, present and

- forecast including radio bursts, coronal mass ejections, solar flares, sudden ionospheric disturbances, or any other flight hazard affecting radio communications and navigation frequencies during flight.
2. Pilot considers all communication frequency and navigation information as appropriate to the mission, and proceeds per approval of the FAA during flight.
  3. Pilot has access to all QICP websites identifying communication and navigation data useful to flight.
  4. Prior to flight, pilot shall gather hazardous communication and navigation weather information and take the appropriate actions to complete UAS mission planning preparations.
  5. The UAS shall be able to mitigate communication and navigation impacts due to hazardous solar environmental and/or space weather conditions. This requirement ensures the UAS is able to communicate and navigate effectively while airborne.

NOTE: Forecast information at altitudes FL450 and FL530 is available via special request (Reference: AT publication 7110.10R, paragraph 9-4-2).

- b. STEP 1 Procedures. The process of developing weather support procedures for Access 5 HALE UAS flight operations will evolve over the life of the Access 5 program. This document provides an initial, set of support procedures for STEP 1 flight operations. These procedures are intended to provide a starting point for the STEP 1 scope of the Access 5 flight weather support process. As the initial and follow-on HALE UAS simulation and flight test events take place and weather impacts are better known, these procedures will evolve over time and will be expanded, refined, and updated accordingly. For the FY04 deliverable, an investigation was completed on key flight operations documents and resulted in outlining the Access 5 STEP 1 procedures listed below.
  - i. Access 5 (A5) UAS pilots access, monitor, and review AFSS/FSS flight weather briefing information and take the appropriate actions based on the following:
    1. Forecast and actual winds along the planned route and altitude.
    2. Forecast and actual air temperatures along the planned route and altitude.
    3. Forecast and observed areas of flight hazards along the planned route and altitude.
    4. Forecast and observed solar/space weather events and the affected communication and navigation of the flight.
    5. Updates to communication and navigation information affecting the planned route, altitude, and duration of the flight.

- ii. A5 UAS pilots review any applicable sections of Air Traffic order 7110.10R, Flight Services, with specific reference to Chapter 9, FAA Weather Services relating to the mission objectives for STEP 1 flight operations.

NOTE: FAA document, Advisory Circular (AC) 00-45E, December 1999 (revised), Aviation Weather Services, is the Air Traffic publication weather services reference in publication 7110.10R for detailed information on weather services provided to FAA certified aircraft.

- iii. A5 UAS pilots make any necessary arrangements for compliance regarding weather knowledge requirements relating to Air Traffic order 7210.3T, Facility Operation and Administration, with specific reference to Part 4, Chapter 14, Aviation Meteorological Services and Equipment.
- iv. A5 UAS pilots make the necessary arrangements to have the highest speed access to ATC Service A circuits to receive updated weather information.
- v. While operating aircraft at STEP 1 altitudes, A5 UAS pilots have access to and monitor AIRMETs/SIGMETs and other available hazard information such as HIWAS or on-board visual monitoring devices.
- vi. A5 UAS pilots monitor weather sources for updates and take the appropriate routine and contingency actions regarding route adjustments based on the following weather criteria for STEP 1 flight information at or above FL430:
  - 1. Forecast winds at the expected operating altitude at or above FL430
  - 2. Forecast temperatures at the expected operating altitude
  - 3. Forecast areas of flight hazards (turbulence or icing) of any intensity at the expected operating altitude at or above FL430
  - 4. Forecast areas of thunderstorms along or near the route of flight.
  - 5. Recent, current and forecast solar environmental events/activity that could affect radio communications and navigation of flight at or above FL430.
  - 6. Updated weather information affecting contingency management and emergency divert weather for flight missions at or above FL430.
- vii. A5 UAS pilots conduct the necessary contingency management planning for contingencies affecting flight at FL430 or above.

NOTE: Forecast information at altitudes FL450 and FL530 is available via special request (Reference: AT publication 7110.10R, paragraph 9-4-2).

- 7. Step 1 Flight Scenario. To test the validity of gathering and employing weather information for a Step 1 mission profile, a flight scenario was created for a two-day mission. This scenario is presented as a separate Microsoft PowerPoint attachment (WX\_001 Appendix A). The information included in the PowerPoint presentation includes sample data and products

related to the each mission segment. In addition, this scenario was used as an initial verification and validation of the Step 1 Weather Functional Requirements.

8. References. The references used to develop the requirements are listed below. Where possible the most current web-available references were used to discern the specific weather support requirements for Access 5 HALE UAS STEP 1 operations.
- a. Air Traffic publication 7110.10R, Flight Services, August 5, 2004
  - b. Air Traffic Order 7210.3T, Facility Operation and Administration, August 5, 2004
  - c. Air Traffic Aeronautical Information Manual, August 5, 2004
  - d. FAA Advisory Circular, AC 00-45E, Aviation Weather Services, Revised December 1999
  - e. FAA Advisory Circular, AC 90-99, High Altitude Airspace Redesign Phase 1, September 22, 2003
  - f. FAA Advisory Circular, AC 00-62, Internet Communications of Aviation Weather and NOTAMs
  - g. National Airspace System Weather Functional Analysis, FAA Workgroup Report, February 12, 2004
  - h. FAA Guide, FAA-G-8082-13A, Instrument Rating Knowledge Test Guide, October 15, 2003
  - i. National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Space Environment Center, <http://www.sec.noaa.gov/index.html>
  - j. National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS), Aviation Weather Center (AWC), Aviation Digital Data Service (ADDS), <http://adds.aviationweather.noaa.gov/>
  - k. Functional Requirements Document for HALE UAS Operations in the NAS, Step 1, Version 2, September 2005

## Verification Matrix

<b>FRD #/ Description</b>	<b>Verification Method</b>	<b>Additional Verification Required</b>
5.4.3 Avoid Hazardous Weather	Flight scenario created to determine open internet access to weather data	Flight Simulation and Flight Demonstration
5.4.3.1 Maintain Weather Awareness	Flight scenario weather awareness data and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration
5.4.3.1.1 Gather Weather Information	Flight scenario weather awareness data and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration
5.4.3.1.1.1 Request Weather Information (HSI F8b)	Flight scenario weather awareness data and information accessed via open internet at ADDS	HSI, Flight Simulation, and Flight Demonstration
5.4.3.1.1.2 Convey Weather Information to the UAS Pilot (HSI F8a)	NA, need HSI verification	HSI, Flight Simulation and Flight Demonstration
5.4.3.1.2 Evaluate Potential for Weather Conflicts	Flight scenario weather awareness data and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration
5.4.3.2 Coordinate Weather Avoidance Maneuver	Flight scenario weather awareness data and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration
5.4.3.3 Command Weather Avoidance Maneuver	Flight scenario weather awareness data and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration
5.4.3.3.1 Control the Weather Awareness System (HSI F8c)	NA, need HSI verification	HSI, Flight Simulation and Flight Demonstration
5.4.3.4 Execute the Weather Avoidance Maneuver	Flight scenario weather awareness data for contingency scenario and information accessed via open internet at ADDS	Flight Simulation and Flight Demonstration



# Wx\_001 Appendix A



*The following document was prepared by a collaborative team through the noted work package.  
This was a funded effort under the Access 5 Project*

# Flight Scenario

A High Altitude Long Endurance (HALE) Unmanned Air System (UAS) flight was conducted between 8 September 2005 and 10 September 2005 to collect chemical data from upper air (FL480) systems i.e. ozone concentration, NO<sub>x</sub> levels, etc.

This flight began on 8 September 2005 from Edwards Air Force Base in southern California and ended on 10 September 2005 at Andrews Air Force Base in the Washington D.C. area.

During the mission there were two orbiting/data collection sessions which took place enroute to Andrews from Edwards. Each orbiting/data collection session lasted approximately 12 hours. The orbiting sessions were conducted between Denver, CO and Kansas City, MO and between Indianapolis, IN and Detroit, MI.

This presentation is designed to show that sources of flight weather information are readily available to UAS pilots to conduct successful UAS missions in the NAS. All weather information for this presentation was obtained from the public internet. Weather information closest to the mission times is presented.

Assumptions:

- UAS cruises at 200 kts

- Climb to and descent from altitude FL480 takes 1.5 hours

# Our Mission Objectives

The objectives of this mission are as follows:

- To depict the necessary weather data that must be accessible via a QICP weather provider to UAV pilots in order to conduct safe and successful missions
- To explain the knowledge that must be extrapolated from the weather data sources
- To show the complexity of forecasting weather for HALE missions
- To show potential contingency scenarios that may result from emergency situations
- To show the importance of weather to the overall success of the mission.

# Schedule of Flight

**Begin:** Edwards AFB 1700 UTC (10:00 am PDT) 8 September 2005

Collected the following weather information:

Turbulence data, Convective Wx Sigmet/Airmet, Winds/Temps, Icing,  
METAR, Satellite

\* Arrive Denver, CO 2330 UTC 8 September 2005  
Initiate data collection mission

\* Arrive Kansas City, MO 0230 UTC 9 September 2005  
Enter orbit area for data collection mission

\* Orbit between Kansas City and Denver for approximately 12 hours from  
0230 UTC to 1430 UTC on 9 September 2005.

# Schedule of Flight (cont.)

\*Arrive Indianapolis, IN 1900 UTC 9 September 2005.  
Initiate data collection mission

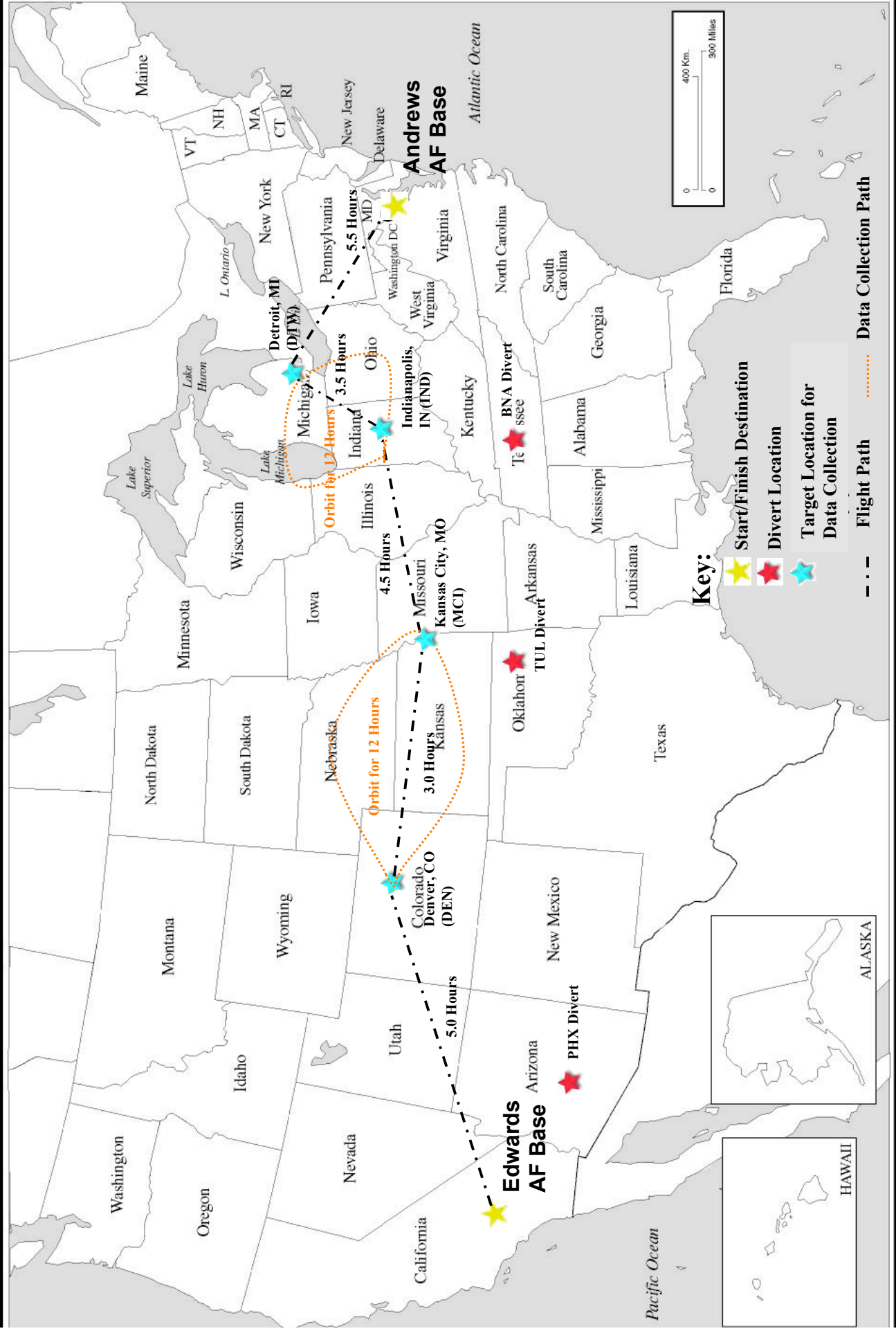
\*Arrive Detroit, MI 2230 UTC 9 September 2005  
Enter orbit area for data collection mission

\*Orbit between Indianapolis and Detroit for approximately 12 hours from  
2230 UTC 9 September 2005 to 1030 UTC 10 September 2005.

Proceed to Andrews AFB to complete flight

**Finish:** Arrive and descend at Andrews AFB at approximately 1600 UTC on 10 September 2005.

# Access 5 Step One Flight Scenario Route



# Weather Data Gathered for Takeoff from Edwards Air Force Base

16Z Takeoff weather for Edwards:

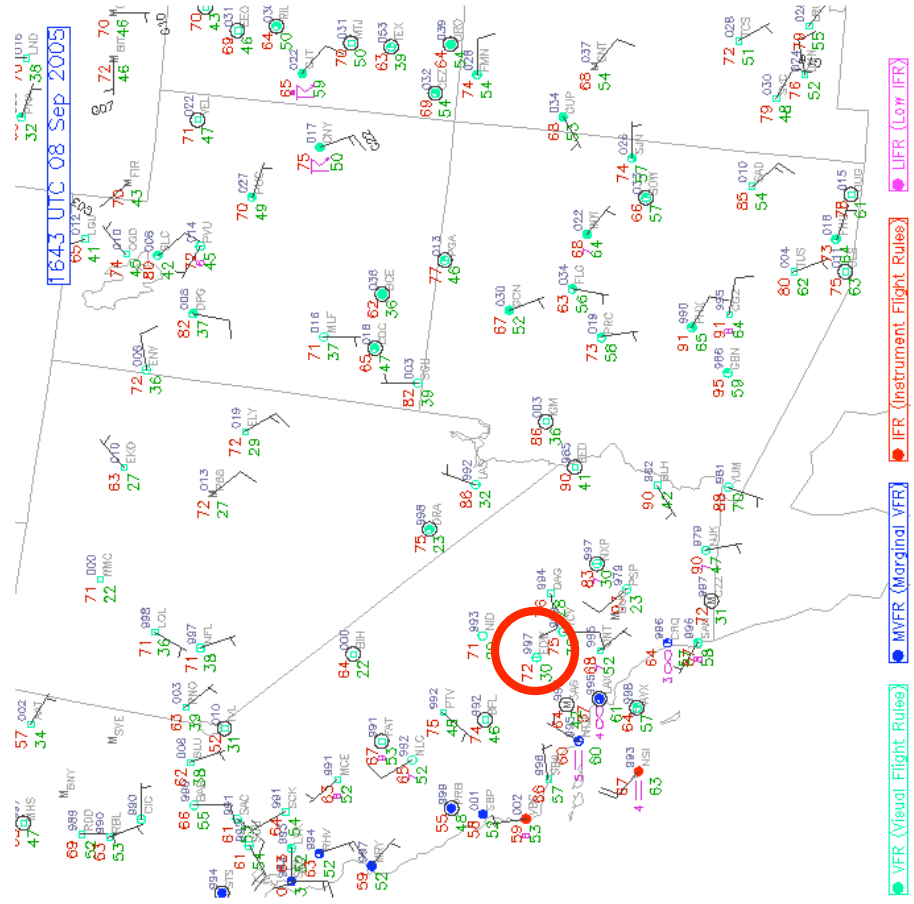
Observations for EDWARDS, CA (EDW)

1455Z 7 Sep 2005 to 1555Z 8 Sep 2005

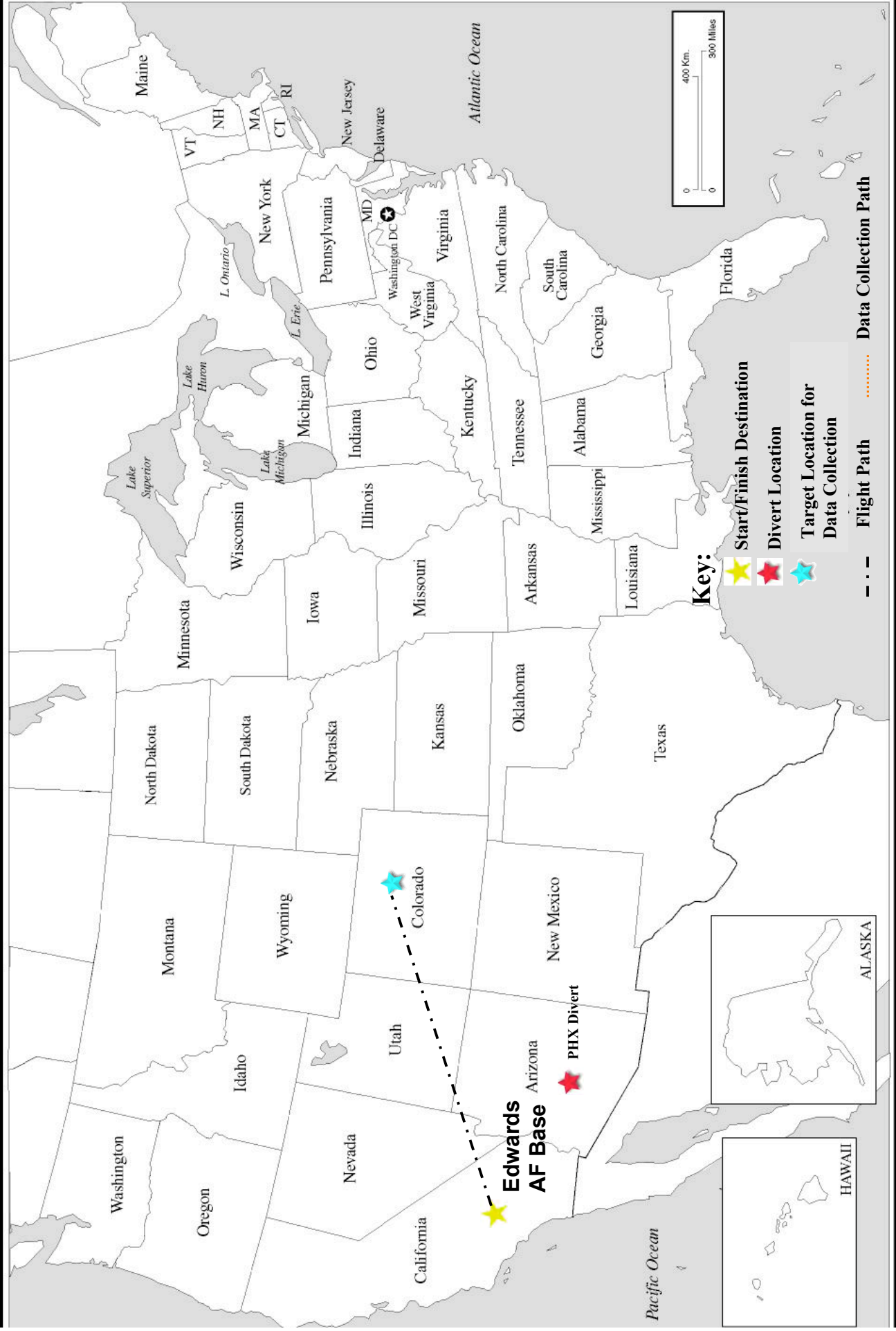
STN	TIME	PMSL	ALTM	TMP	DEW	RH	DIR	SPD	VIS	CLOUDS	MIN
DD/HHMM	hPa	inHg	F	F	%	deg	kt	mile			F
EDW	08/1555	1011.2	29.97	72	30	22		2	85	FEW100	---
EDW	08/1455	1011.0	29.97	72	30	22		3	85	FEW100	---
EDW	08/1355	1011.4	29.96	54	30	41		4	85	FEW100	---
EDW	08/1255	1010.9	29.94	54	28	38		2	85	FEW100	62
EDW	08/0455	1010.6	29.94	72	23	16	220	4	30	SCT300	---
EDW	08/0355	1010.2	29.93	77	27	15	240	4	30	SCT300	---
EDW	08/0255	1009.9	29.91	79	32	18	240	9	30	SCT300	---
EDW	08/0155	1009.8	29.90	86	19	9	240	11	85	SCT300	---
EDW	08/0055	1009.6	29.90	88	16	7	250	13	85	SCT300	---
EDW	07/2355	1008.6	29.90	93	19	7		5	85	SCT300	---
EDW	07/2255	1009.2	29.91	93	18	6		2	85	SCT300	---
EDW	07/2155	1009.8	29.94	91	18	7	300	2	85	SCT300	---
EDW	07/2055	1011.1	29.96	90	18	7	260	5	85	SCT320	---
EDW	07/1955	1011.3	29.98	90	19	8	340	2	85	SCT250	61
EDW	07/1855	1012.3	30.01	86	23	10		4	85	SCT250	---
EDW	07/1755	1012.7	30.02	81	27	14		3	85	BKN250	---
EDW	07/1655	1013.5	30.03	73	28	19		4	85	BKN250	---
EDW	07/1555	1013.8	30.03	66	28	24		2	85	BKN250	---
EDW	07/1455	1013.8	30.03	63	30	29	0	0	85	SCT250	---

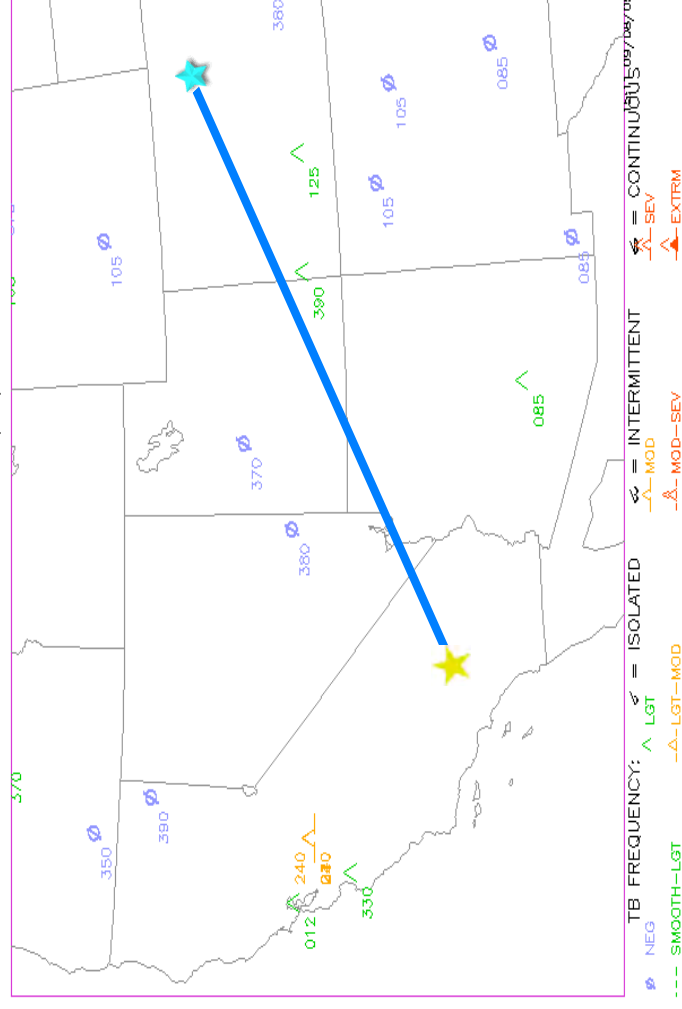
Few clouds at 100, no ceiling. Winds variable at 2kts.

Local area weather chart at takeoff time



# Flight Scenario First Leg





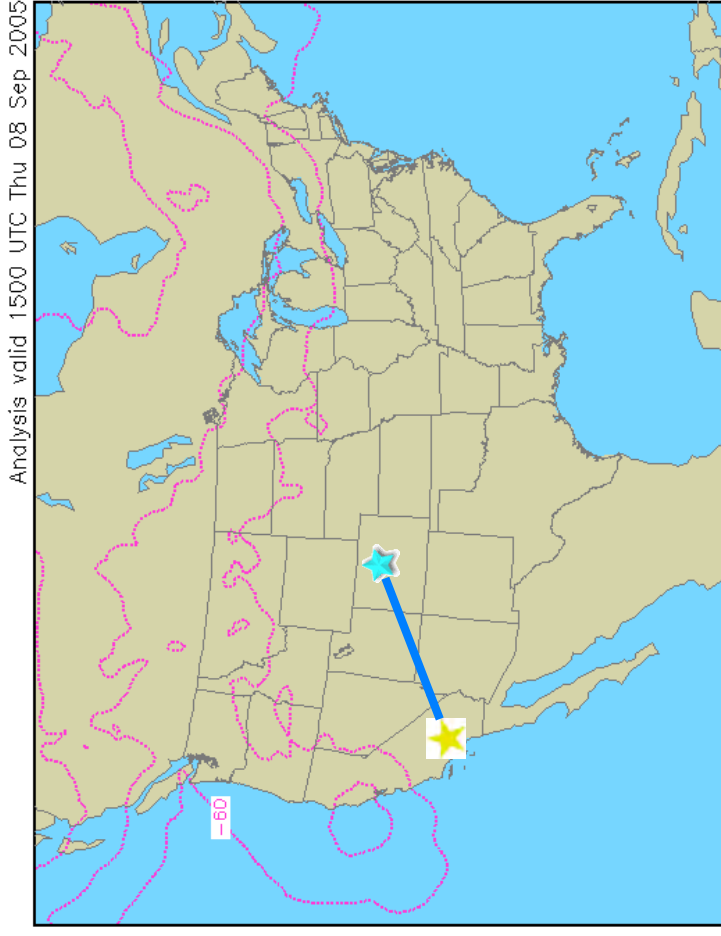
## Wind Speed:

Wind Speed Analysis for  
FL480 over the Contiguous  
United States at 1500 UTC:

## Temperature:

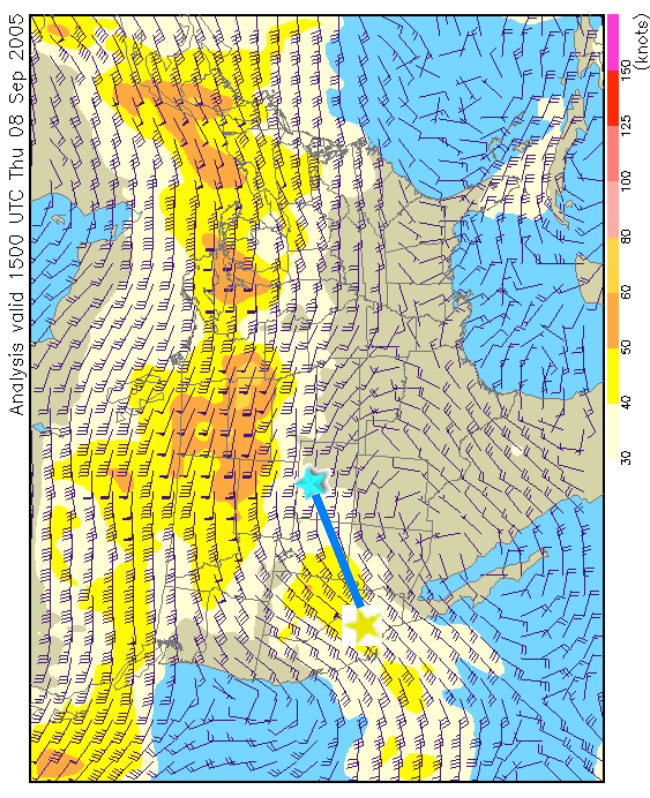
Temperature Forecast for  
FL480 over the Contiguous  
United States at 1500 UTC:

Temperature (°C) at 48,000 ft MSL (125 mb)



The temperature is  
approximately -60 degrees  
Celsius at FL480.

Wind speed (kts) at 48,000 ft MSL (125 mb)

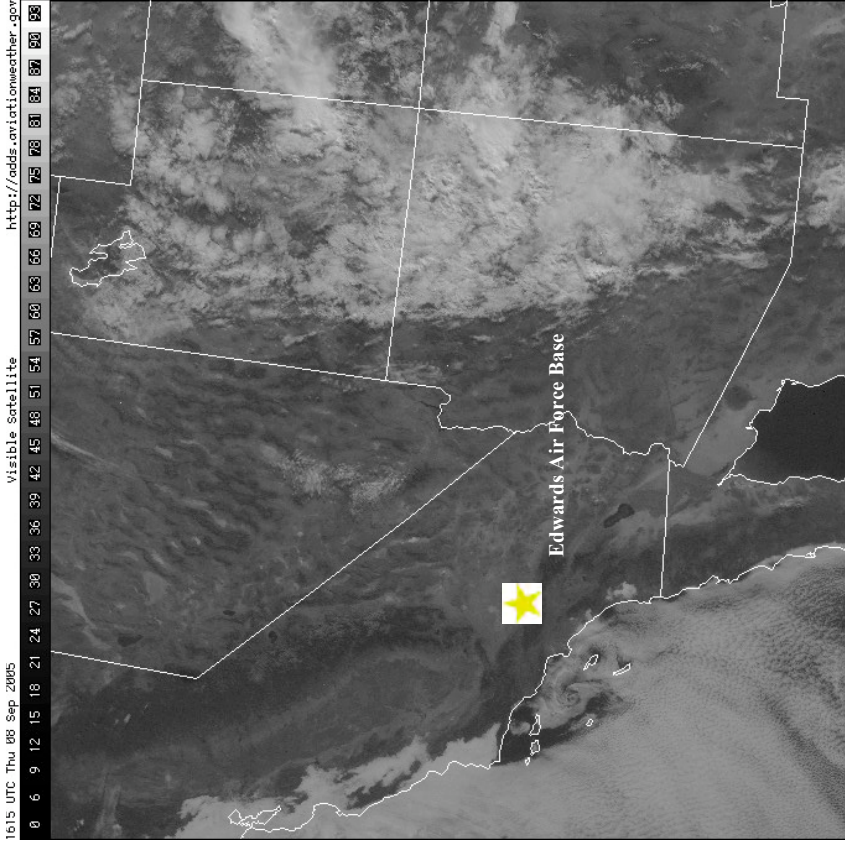
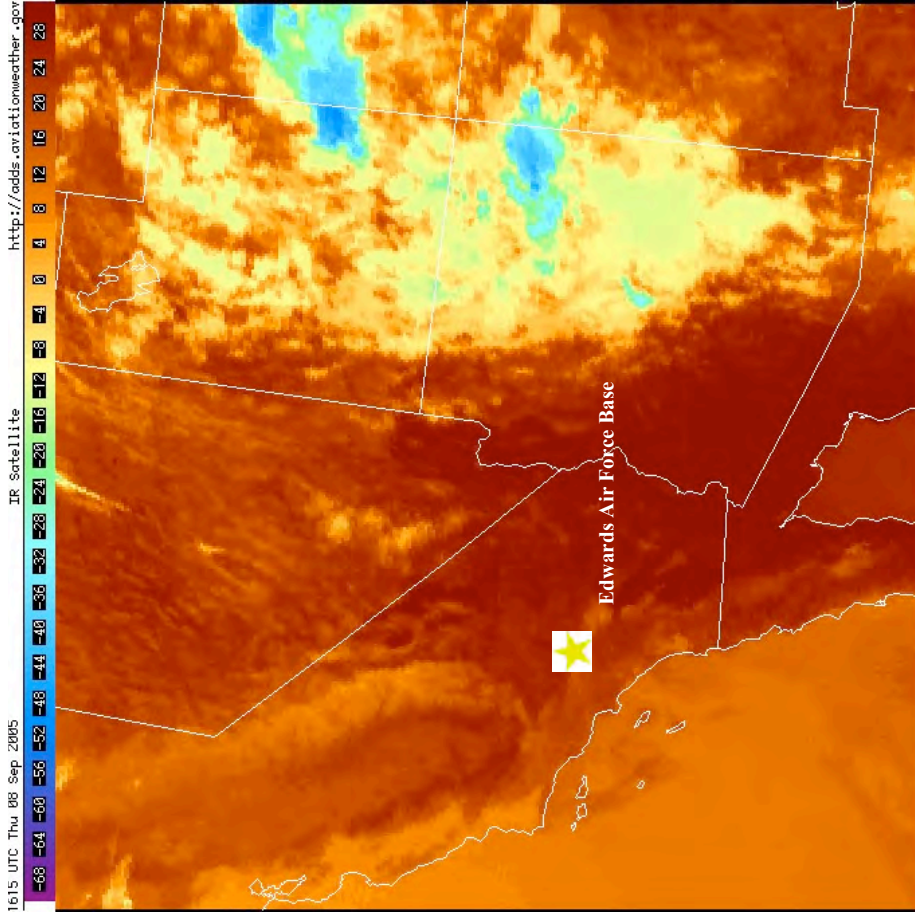


**FL480 enroute winds  
from Edwards AFB to  
Denver orbit area  
average 40 knots from  
the southwest**

## Satellite Imagery:

Visible Satellite Imagery  
for Edwards AFB and  
surrounding Area: →

Infrared satellite imagery at 1615Z indicates  
showers and possible isolated thunderstorms  
later in the day over N Arizona and E  
Utah/central Colorado. These could affect  
the entry into the Denver orbit area.



Visible satellite imagery at 1615Z  
indicates some clouds located over the N  
Arizona and E Utah/central Colorado  
area.

←  
Infrared Radar Imagery from Edwards  
AFB and surrounding Area:

## METAR Outlook for the Denver Area:

Broken clouds with ceiling at 200. Winds from the west at 10 knots. Thunderstorms beginning at 2224 UTC were present with occasional cloud to ground lightening to the northeast with additional distant thunderstorms to the northeast-east moving toward the northeast.

## Observations for DENVER, CO (DEN)

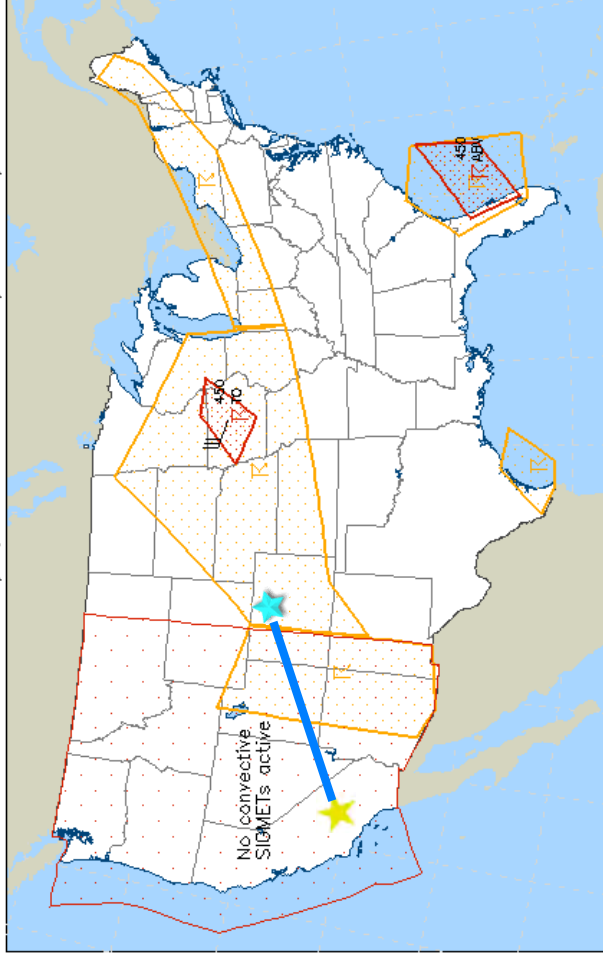
KDEN 082253Z 23010KT 10SM TS FEW080CB SCT095 SCT130 BKN200 32/06 A3006 RMK AO2 TSB24 SLP095 OCNL LTGCG VC NE AND DSNT NE-E TS VC NE MOV SLO NE VIRGA DSNT A  
KDEN 082207Z 19011G23KT 10SM TS FEW080CB SCT095 SCT130 BKN200 31/07 A3006 RMK AO2 TSB24 OCNL LTGCG VC NE AND DSNT NE-E TS VC NE MOV SLO NE VIRGA DSNT A  
KDEN 082153Z 33006KT 10SM SCT080 BKN130 BKN220 32/06 A3006 RMK AO2 SLP095 OCNL LTGCG DSNT NE SE VIRGA E AND DSNT NE-E TS VC NE MOV SLO NE SHRA  
KDEN 082053Z 32009G15KT 10SM SCT080 BKN130 BKN220 32/06 A3010 RMK AO2 SLP107 OCNL LTGCG DSNT S VIRGA DSNT SE-S AND W CB DSNT SE-S MOV E TCU VC NE T031700078  
KDEN 081953Z 32007KT 300V360 10SM FEW090 SCT130 BKN220 32/06 A3012 RMK AO2 SLP112 VIRGA DSNT SE-S AND W TCU DSNT SE-S T031700061  
KDEN 081853Z 31008KT 10SM FEW080 SCT110 SCT150 BKN220 31/08 A3015 RMK AO2 SLP120 VIRGA DSNT S-W ACSL DSNT E T031100083  
KDEN 081753Z VRB03KT 10SM FEW080 SCT110 BKN220 28/08 A3018 RMK AO2 SLP132 TCU DSNT S ACSL DSNT E AND W T028300083 10300 20139 58007  
KDEN 081653Z 00000KT 10SM FEW090 BKN130 BKN220 27/10 A3019 RMK AO2 SLP141 T02670100  
KDEN 081553Z 27005KT 10SM FEW090 SCT120 BKN220 24/12 A3020 RMK AO2 SLP143 ACSL DSNT W T02440117  
KDEN 081453Z 29004KT 10SM FEW100 BKN120 BKN200 23/10 A3020 RMK AO2 SLP144 ACSL DSNT SW-W T02330100 51002  
KDEN 081353Z 24007KT 10SM FEW100 BKN120 BKN200 19/11 A3020 RMK AO2 SLP149 T01940111  
KDEN 081253Z 25006KT 10SM BKN120 BKN200 15/11 A3019 RMK AO2 SLP148 T01500111  
KDEN 081153Z VRB05KT 10SM SCT120 BKN200 17/11 A3019 RMK AO2 SLP139 T01670111 10200 20139 58002  
KDEN 081053Z VRB05KT 10SM FEW110 SCT200 14/11 A3020 RMK AO2 SLP145 T01390106  
KDEN 080953Z COR 31005KT 10SM FEW110 SCT200 17/12 A3020 RMK AO2 SLP139 T01720117  
KDEN 080853Z 26006KT 10SM SCT110 BKN200 17/11 A3020 RMK AO2 SLP139 T01720111 58005  
KDEN 080753Z 26008KT 10SM FEW110 SCT200 18/12 A3021 RMK AO2 SLP144 T01830117  
KDEN 080653Z 19014KT 10SM SCT110 SCT200 19/12 A3021 RMK AO2 SLP144 T01940117 403220122  
KDEN 080553Z 16012KT 10SM SCT110 SCT200 20/11 A3022 RMK AO2 SLP149 T02000111 10306 20200 50005  
KDEN 080453Z 13013KT 10SM SCT110 BKN200 20/12 A3022 RMK AO2 SLP154 T02000117  
KDEN 080353Z 13012KT 10SM FEW080 BKN110 BKN200 23/11 A3021 RMK AO2 SLP151 CB MOV E T02280111  
KDEN 080253Z 12006KT 10SM FEW080 SCT120 BKN200 23/09 A3020 RMK AO2 SLP149 OCNL LTGIC DSNT E CB DSNT E MOV E T023300089 53008  
KDEN 080153Z 15008KT 10SM FEW080 SCT130 SCT200 23/06 A3018 RMK AO2 SLP149 OCNL LTGIC DSNT E AND SE CB DSNT E AND SE MOV E T023300056  
KDEN 080053Z 05007KT 10SM FEW080 SCT095 SCT130 SCT200 28/02 A3017 RMK AO2 SLP140 VIRGA DSNT W CB DSNT E AND SE AND SW MOV E TCU DSNT S T02780017  
KDEN 072353Z VRB04KT 10SM FEW080 SCT130 SCT200 31/01 A3017 RMK AO2 SLP135 VIRGA DSNT W CB DSNT NE AND SE MOV E TCU DSNT E T03060006 10322 20261 56010  
KDEN 072253Z VRB06KT 10SM FEW085 SCT120 SCT200 32/01 A3018 RMK AO2 SLP140 VIRGA DSNT W CB DSNT NE AND SE MOV E TCU DSNT SE T03170011  
KDEN 072153Z VRB05KT 10SM FEW080 SCT120 SCT200 32/02 A3019 RMK AO2 SLP142 CB DSNT N MOV E TCU DSNT E-S T03170022

# Significant Weather Advisories:

Convective SIGMET for the  
Contiguous U.S.:

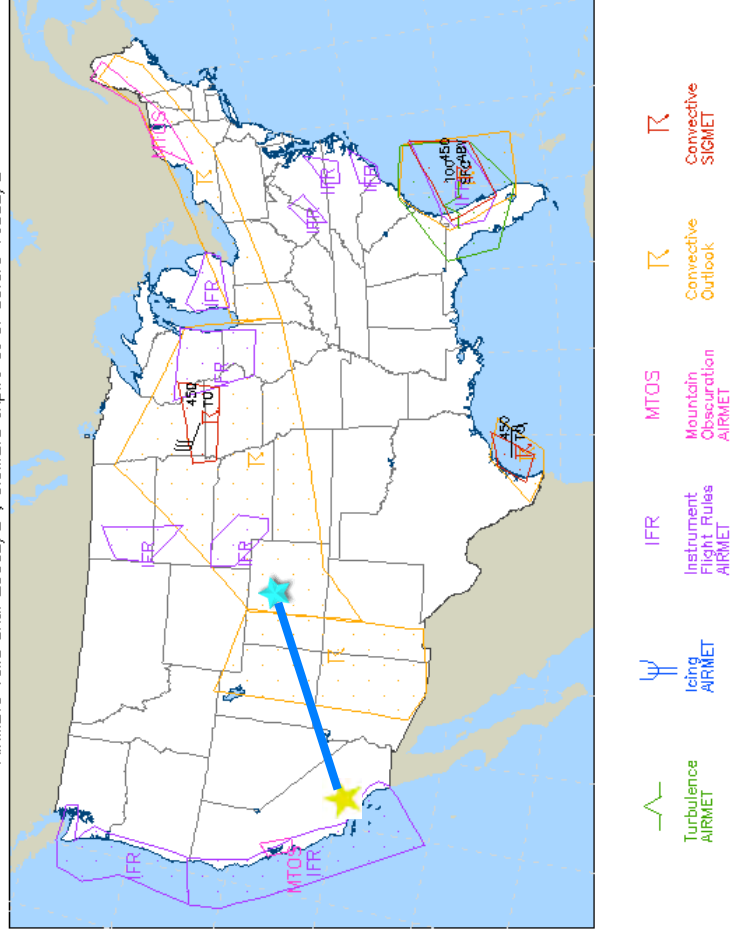
**There is the potential for isolated  
convective weather for this portion of  
flight.**

Convective SIGMETs (red) and outlooks (orange)  
chart created at 1855 UTC Thu 08 Sep 2005  
SIGMETs valid until 1855z/8<sup>th</sup>, Outlooks valid from 1855z/8<sup>th</sup> to 2255z/8<sup>th</sup>

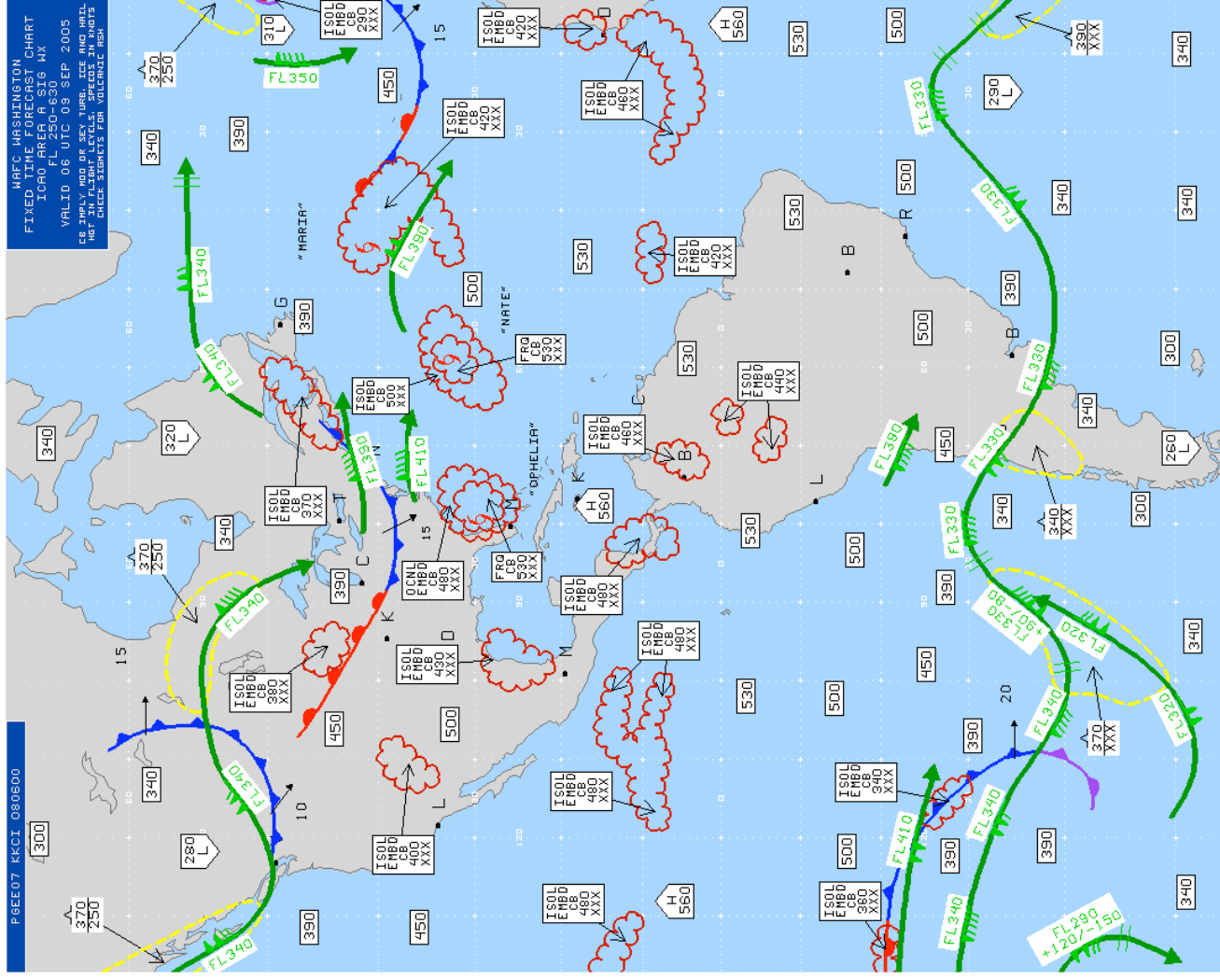


All active AIRMETs and SIGMETs  
for the continental U.S.:

All active AIRMETs and SIGMETs  
chart created at 1455 UTC Thu 08 Sep 2005  
AIRMETs valid until 2000z/8<sup>th</sup>, SIGMETs expire at or before 1655z/8<sup>th</sup>



# High-Level Weather Fixed Time Forecast Chart for FL250-FL630: No significant weather for our mission profile.



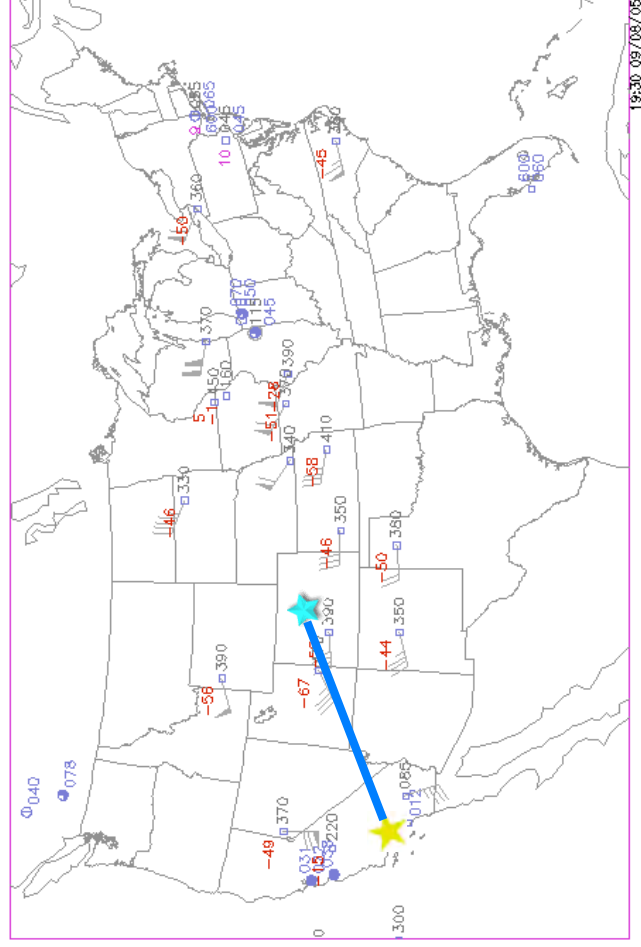
## Divert Weather:

PIREPs Turbulence for the  
Continental U.S. on 8  
September 2005:

**There is light to moderate  
turbulence in the Denver  
area at this time.**

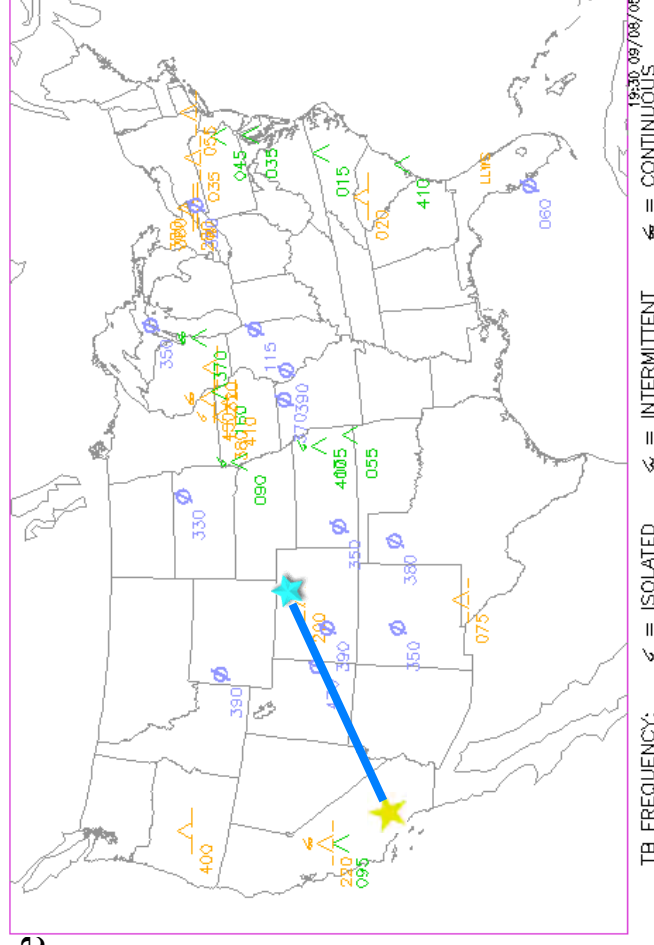
Pilot Reports (PIREPs) of Weather and Sky Conditions

1759z - 1925z 09/08/05



Pilot Reports (PIREPs) of Turbulence

1800z - 1919z 09/08/05

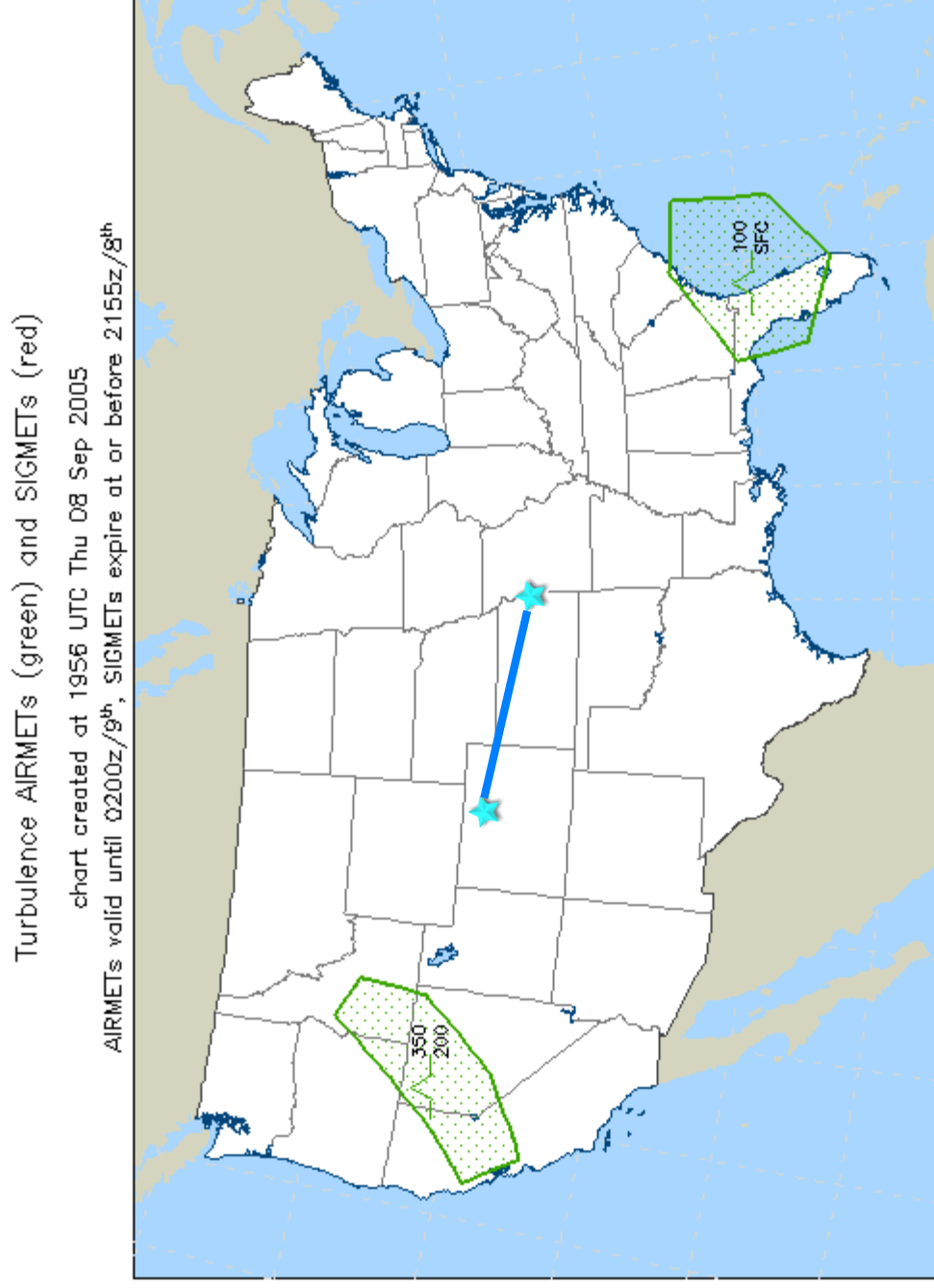


**PIREPs of Weather and Sky  
Conditions for the continental U.S.:**



**Current mission time: approximately 2330 UTC on 8 September 2005**

**Flight status: entering mission orbit area 1, and heading to Kansas City, MO for 0230 UTC on 9 September 2005.**

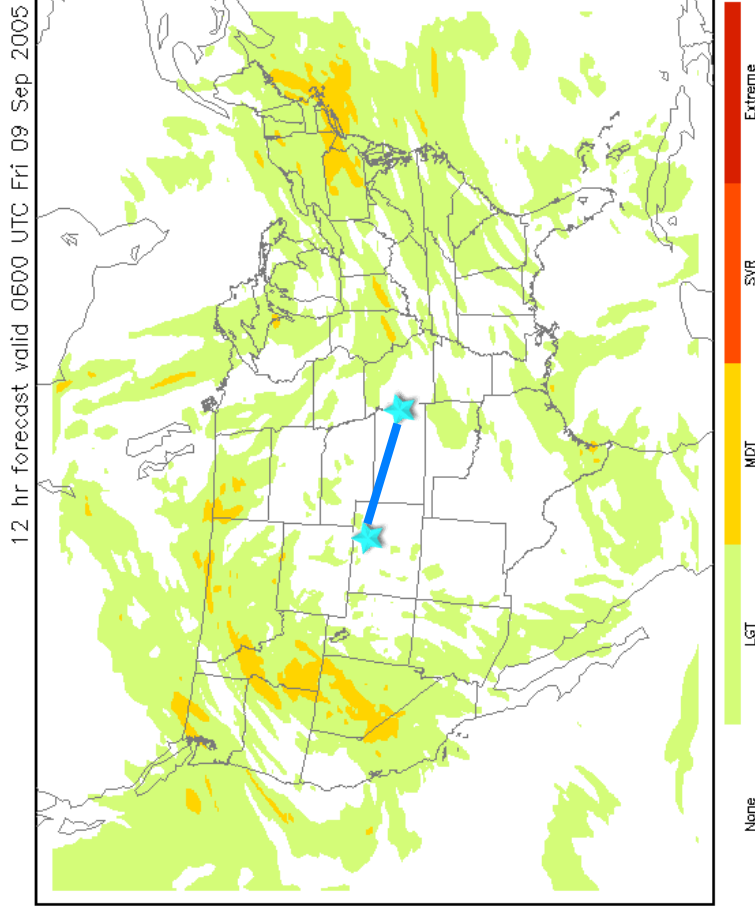


Turbulence Forecast at  
FL450 for 0000 UTC on  
9 September 2005:



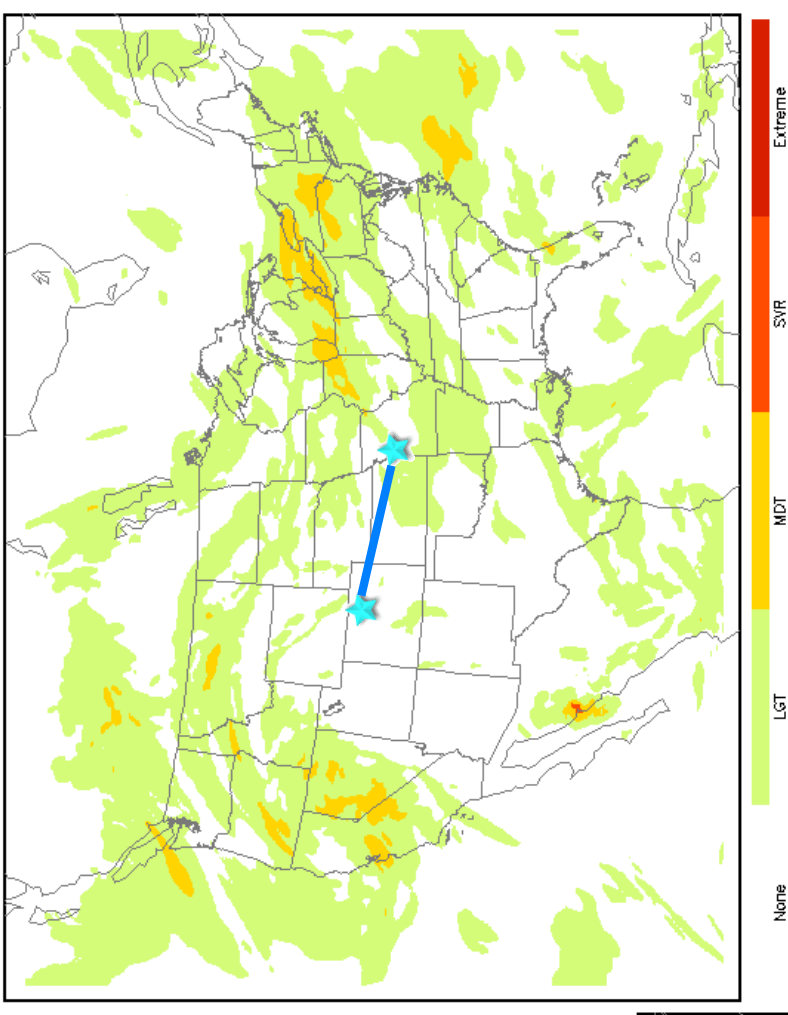
**Heading from Denver, CO to Kansas  
City, MO and orbiting for 12 hours  
in between the two locations  
beginning data collection.**

Turbulence forecast at FL450



Turbulence forecast at FL450

06 hr forecast valid 0000 UTC Fri 09 Sep 2005



**Turbulence of light intensity or less is  
expected along the flight path.**

Turbulence Forecast at FL450 for  
0600 UTC on 9 September 2005:

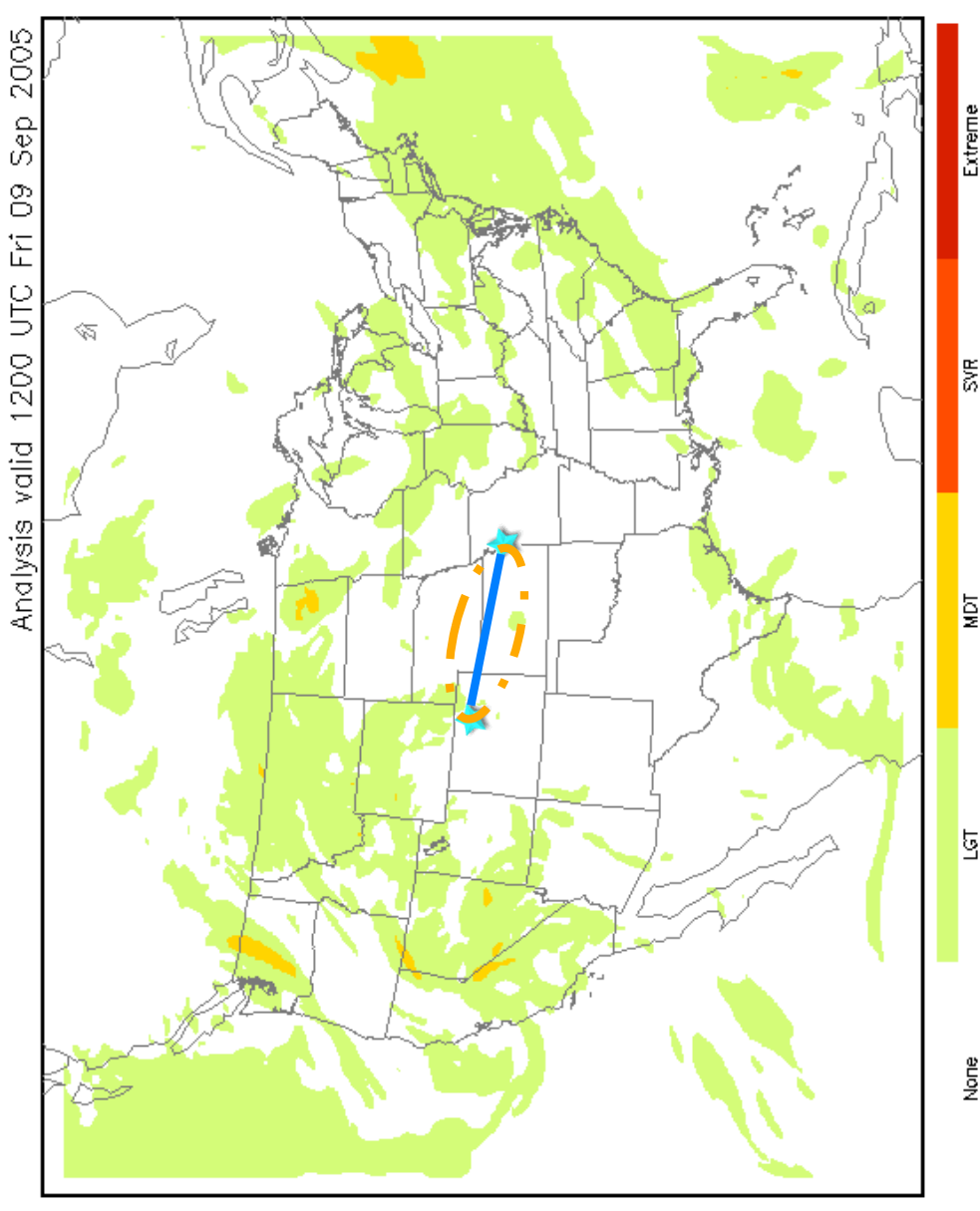


Turbulence forecast at FL450  
valid 1200 UTC on 9  
September 2005.

**Currently orbiting and  
collecting data between  
Denver, CO and Kansas  
City, MO.**

**There is light to moderate  
turbulence for FL450 in  
the western orbit area  
during this portion of  
flight.**

## **Turbulence forecast at FL450**



Turbulence AIRMETs and SIGMETs as of  
1355 UTC on 9 September 2005:

**Turbulence is  
expected from  
surface to FL080  
between Denver and  
Kansas City.**

**This would affect any  
divert to Kansas  
City.**

Turbulence AIRMETs (green) and SIGMETs (red)

chart created at 1355 UTC Fri 09 Sep 2005

AIRMETs valid until 2000z/g<sup>h</sup>, SIGMETs expire at or before 1555z/g<sup>h</sup>



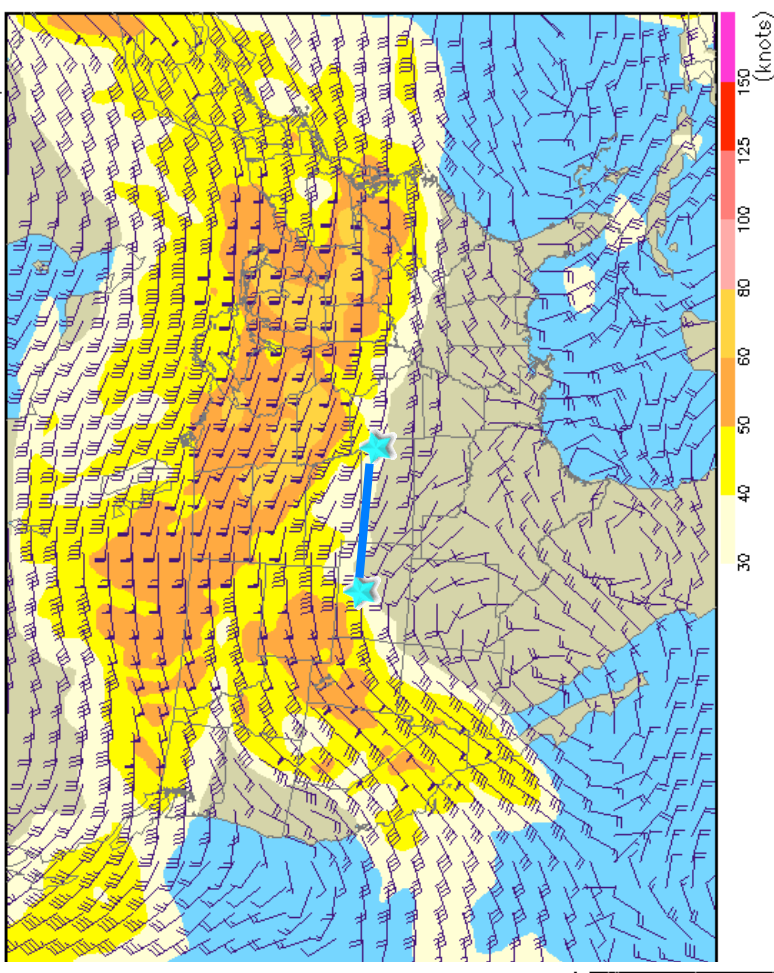
Wind Speed at FL480 at 0000  
UTC 9 September 2005:



The winds for this portion of flight  
decrease from 40 to 30 kts from the  
northwest as the flight moves toward  
Kansas City.

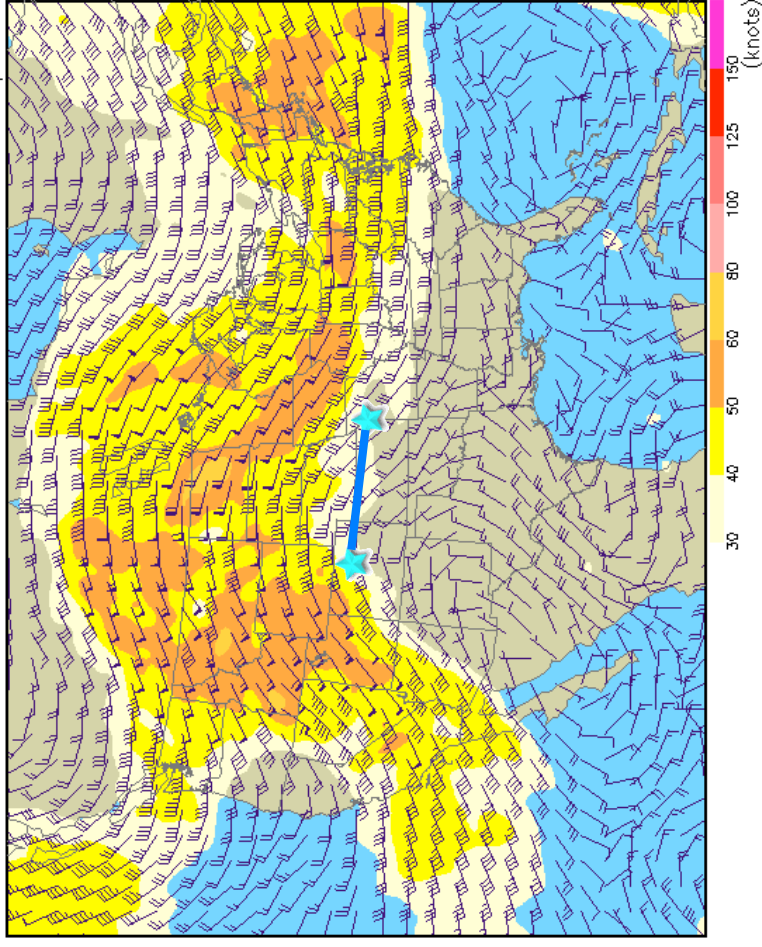
Wind speed (kts) at 48,000 ft MSL (125 mb)

06-hour forecast valid 0000 UTC Fri 09 Sep 2005



Wind speed (kts) at 48,000 ft MSL (125 mb)

12-hour forecast valid 0600 UTC Fri 09 Sep 2005

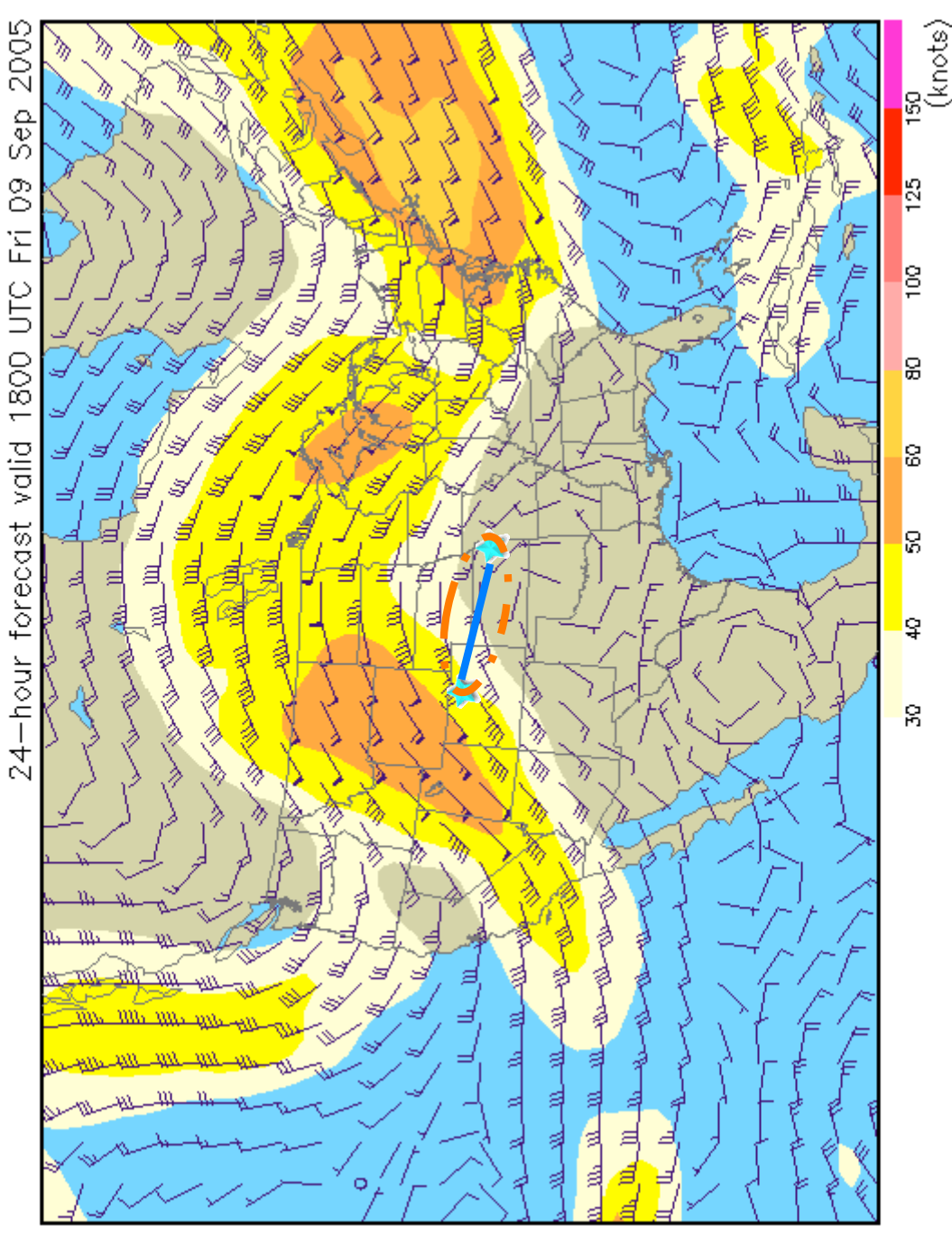


Wind Speed at FL480 at 0600  
UTC 9 September 2005:

Wind Speed Chart at FL480 for  
18UTC on 9 September 2005:

**Winds from Denver  
to Kansas City are  
from the West-  
Southwest at  
approximately 15-45  
knots.**

**Wind speed (kts) at 48,000 ft MSL (125 mb)**



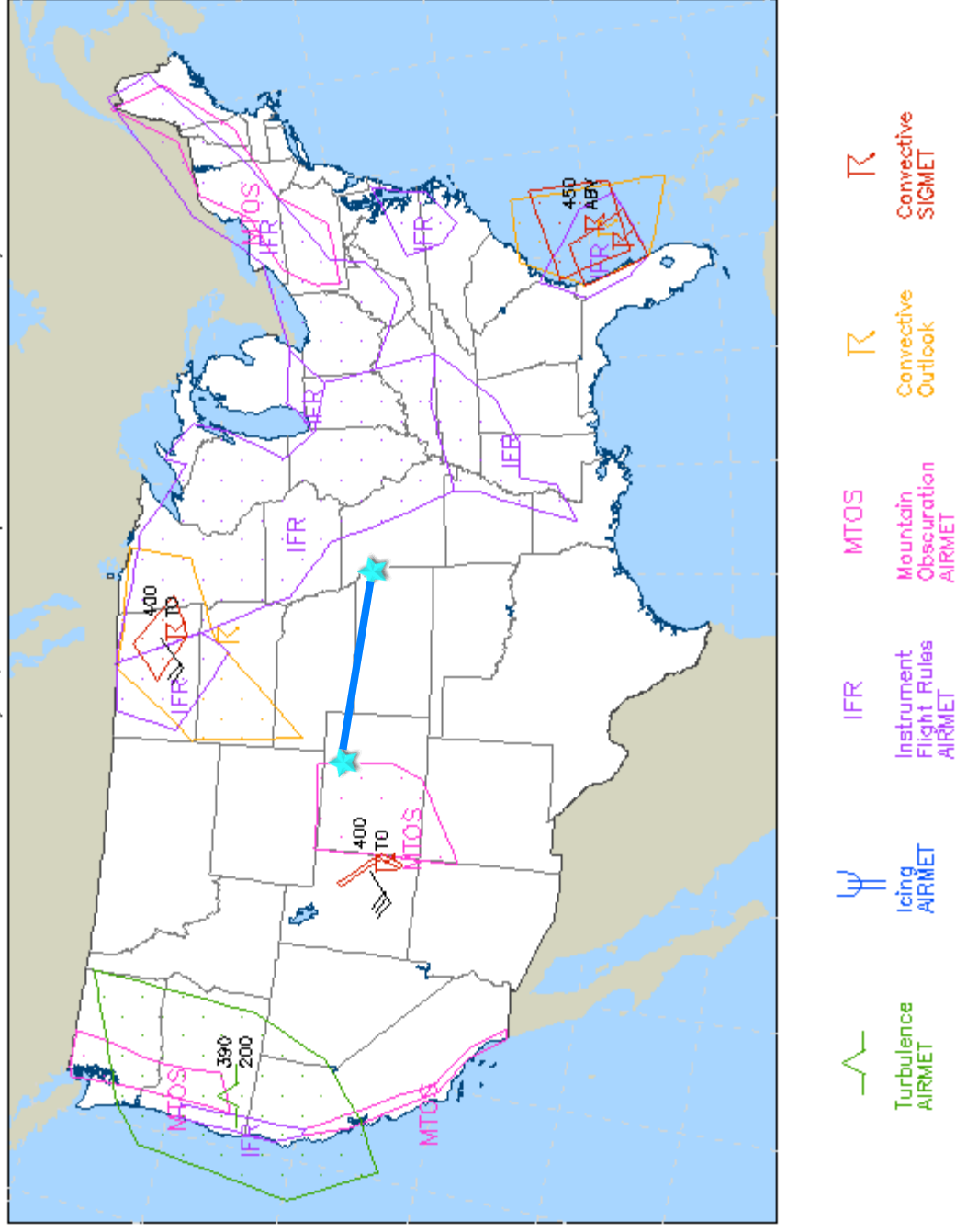
All active AIRMETs and SIGMETs for the continental U.S. as of 1255 UTC on 9 September 2005:

**There is a mountain obscuration AIRMET for the Denver area.**

All active AIRMETs and SIGMETs

chart created at 1255 UTC Fri 09 Sep 2005

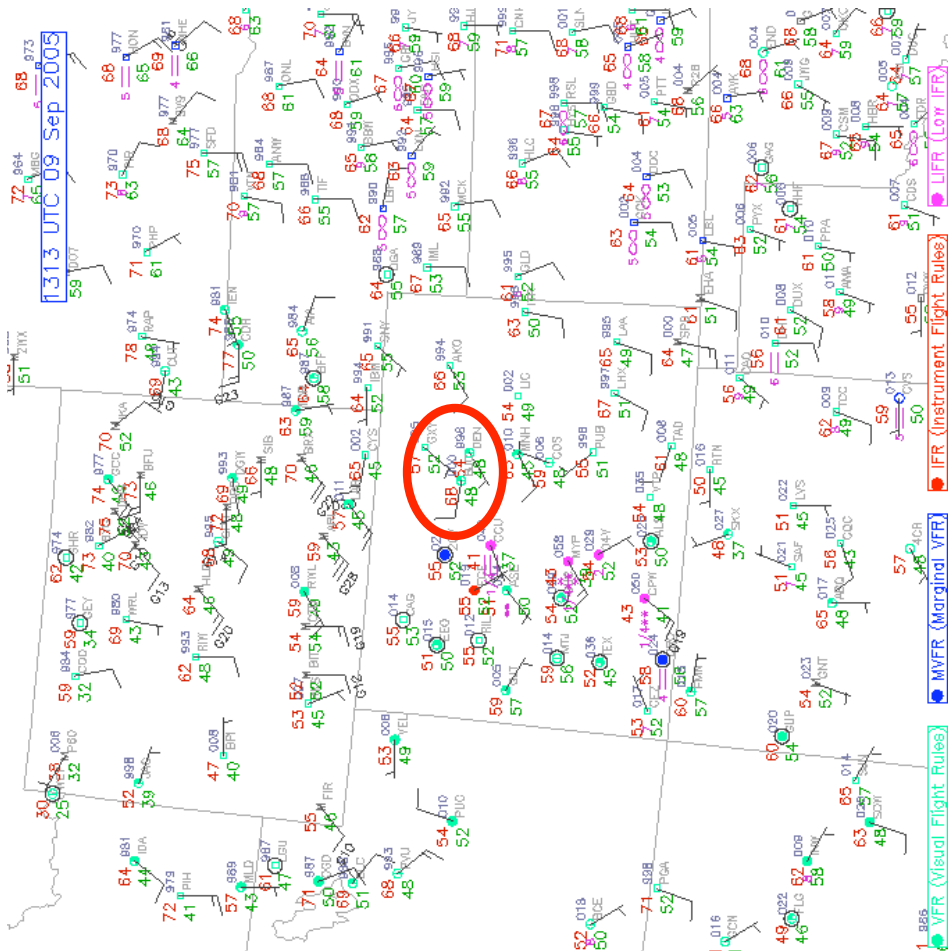
AIRMETs valid until 1400z/9<sup>th</sup>, SIGMETs expire at or before 1455z/9<sup>th</sup>



# METAR for the Denver area at approximately 1300 UTC on 9 September 2005:

## Observations for DENVER, CO (DEN)

KDEN 091253Z 24007KT 10SM FEW060 SCT120 18/09 A2998 RMK A02 SLP071 T017800089  
 KDEN 091253Z 24007KT 10SM FEW060 SCT120 18/09 A2997 RMK A02 SLP071 T017800089  
 KDEN 091053Z 18007KT 10SM SCT120 SCT200 16/08 A2997 RMK A02 SLP061 T016100083  
 KDEN 090953Z 21013KT 10SM SCT120 SCT200 21/09 A2998 RMK A02 SLP057 T020600089  
 KDEN 090853Z 21011KT 10SM BKN120 BKN200 22/09 A2999 RMK A02 SLP059 T022200089 580115  
 KDEN 090753Z 22010KT 10SM FEW090 BKN120 23/09 A3001 RMK A02 SLP066 T022800094  
 KDEN 090653Z 22013KT 10SM SCT090 BKN120 23/09 A3003 RMK A02 SLP071 T022800094 403333  
 KDEN 090553Z 23013KT 10SM SCT090 BKN120 BKN200 23/09 A3005 RMK A02 SLP081 T02330008  
 KDEN 090453Z 24014KT 10SM FEW090 BKN110 BKN200 24/08 A3005 RMK A02 SLP083 T0244007  
 KDEN 090253Z 00000KT 10SM SCT090CB BKN110 BKN130 24/08 A3007 RMK A02 SLP097 OCNL LTGCG DSNT NE VIRGA VC E-  
 KDEN 090153Z 00000KT 10SM FEW080 SCT110 BKN130 BKN200 24/07 A3007 RMK A02 SLP103 OCNL LTGCG DSNT NE VIRGA I  
 KDEN 090053Z 29007KT 10SM FEW080 SCT110 BKN130 BKN200 28/06 A3006 RMK A02 TSB2358E34 SLP101 OCNL LTGCG DSNT  
 KDEN 090040Z 30007KT 10SM FEW080 SCT110 BKN130 BKN200 28/06 A3006 RMK A02 TSB2358E34 TS DSIFT VIRGA DSNT NI  
 KDEN 090004Z 28011KT 10SM TS FEW080CB SCT110 BKN130 BKN200 28/07 A3006 RMK A02 TSB2358 OCNL LTGCG VC NW TS  
 KDEN 082353Z 27012KT 10SM FEW080 SCT100 BKN130 BKN220 29/07 A3006 RMK A02 TSE11 SLP096 TS MOV NE VIRGA DSNT  
 KDEN 082317Z 29010G14KT 10SM FEW080 SCT100 BKN220 31/07 A3006 RMK A02 TSE11 OCNL LTGCG DSNT NE TS M  
 KDEN 082253Z 23010KT 10SM TS FEW080CB SCT095 SCT130 BKN200 32/06 A3006 RMK A02 TSE24 SLP095 OCNL LTGCG VC I  
 KDEN 082230Z 19011G23KT 10SM TS FEW080CB SCT095 SCT130 BKN200 31/07 A3006 RMK A02 TSE24 OCNL LTGCG VC NE AF  
 KDEN 082153Z 33006KT 10SM SCT080 BKN130 BKN220 33/06 A3008 RMK A02 SLP095 OCNL LTGCG DSNT NE-SE VIRGA S ANI  
 KDEN 082153Z 32009G15KT 10SM SCT080 BKN130 BKN220 32/08 A3010 RMK A02 SLP107 OCNL LTGCG DSNT S VIRGA DSNT  
 KDEN 081953Z 32007KT 300V360 10SM FEW090 SCT130 BKN220 32/06 A3012 RMK A02 SLP132 TCU DSNT S ACSL DSNT E AND W T028  
 KDEN 081853Z 32007KT 10SM FEW080 SCT110 BKN220 31/08 A3015 RMK A02 SLP132 TCU DSNT S ACSL DSNT E AND W T028  
 KDEN 081753Z 32007KT 10SM FEW080 SCT110 BKN220 28/08 A3018 RMK A02 SLP143 ACSL DSNT W T02440117  
 KDEN 081653Z 00000KT 10SM FEW090 BKN130 BKN220 27/10 A3019 RMK A02 SLP141 T02670100  
 KDEN 081553Z 27005KT 10SM FEW090 SCT120 BKN220 24/12 A3020 RMK A02 SLP143 ACSL DSNT SW-W T02330100 51002  
 KDEN 081453Z 29004KT 10SM FEW100 BKN120 BKN200 23/10 A3020 RMK A02 SLP144 ACSL DSNT SW-W T02330100 51002  
 KDEN 081353Z 24007KT 10SM FEW100 BKN120 BKN200 19/11 A3020 RMK A02 SLP149 T01940111  
 KDEN 081253Z 25006KT 10SM BKN120 BKN200 15/11 A3019 RMK A02 SLP148 T01500111  
 KDEN 081153Z 32007KT 10SM SCT120 BKN200 17/11 A3019 RMK A02 SLP139 T01670111 10200 20139 58002

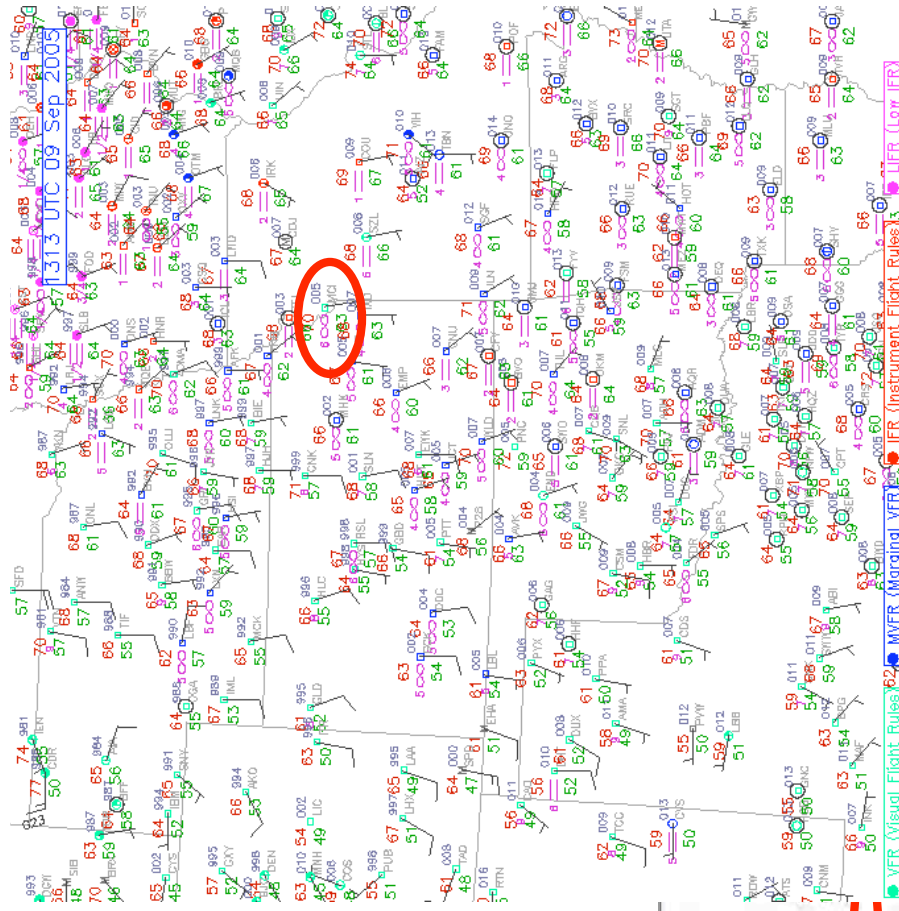


# METAR for the Kansas City area as of 1313 UTC on 9 September 2005:

## Observations for KANSAS, MO (MCI)

1153Z 8 Sep 2005 to 1253Z 9 Sep 2005

STN	TIME	PMSL	ALTM	TMP	DEW	RH	DIR	SPD	VIS	CLOUDS	Weather
DD/HHMM	hPa	inHg	F	F	%	deg	kt	mile			
MCI	09/1253	1016.7	30.05	70	63	78	170	5	6	CLR	H
MCI	09/1153	1016.4	30.04	68	61	78	190	1	6	FEW300	H
MCI	09/1053	1015.9	30.03	69	62	78	190	3	7	CLR	
MCI	09/0953	1015.5	30.02	69	62	78	180	6	8	CLR	
MCI	09/0853	1015.4	30.02	70	62	76	190	6	9	CLR	
MCI	09/0753	1015.4	30.02	71	62	73	190	8	9	CLR	
MCI	09/0653	1015.3	30.02	73	62	68	200	10	9	CLR	
MCI	09/0553	1015.5	30.02	74	63	69	190	10	9	CLR	
MCI	09/0453	1015.4	30.02	72	64	76	180	8	9	CLR	
MCI	09/0353	1015.6	30.02	73	64	73	170	8	9	CLR	
MCI	09/0253	1015.5	30.02	73	65	76	170	9	7	FEW130	
MCI	09/0153	1015.6	30.02	75	65	71	160	7	7	BKN130	
MCI	09/0053	1015.1	30.01	80	65	60	190	9	7	BKN110	
MCI	08/2353	1016.0	30.04	81	67	62	220	3	6	OVC095	
MCI	08/2253	1015.8	30.03	84	66	55	190	8	5	FEW070	BKN110
MCI	08/2153	1016.0	30.04	88	65	46	200	10	7	FEW150	
MCI	08/2053	1016.3	30.05	87	66	50	200	14	6	SCT150	
MCI	08/1953	1017.0	30.07	86	66	51	200	12	7	FEW150	
MCI	08/1853	1017.7	30.09	84	68	59	190	11	6	SCT150	
MCI	08/1753	1018.5	30.11	79	66	65	200	8	5	BKN130	
MCI	08/1653	1019.2	30.13	80	67	64	200	9	5	SCT100	BKN150
MCI	08/1553	1020.0	30.15	77	69	77	140	5	4	FEW080	BKN130
MCI	08/1453	1020.5	30.17	73	68	84	240	6	2	FEW017	BKN070
MCI	08/1353	1019.6	30.14	75	68	79	190	4	4	SCT075	OVC130
MCI	08/1253	1019.3	30.14	74	67	79	170	4	4	SCT075	BKN130
MCI	08/1153	1019.2	30.13	70	66	87	160	5	4	SCT095	BKN250

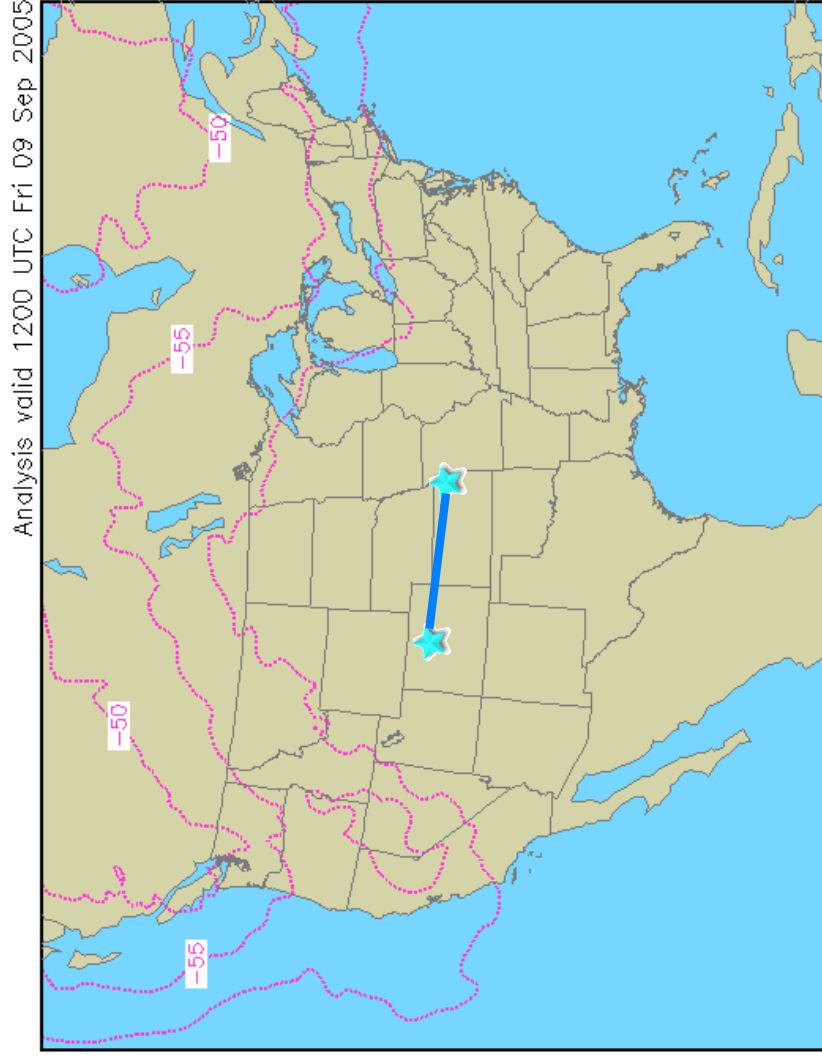


72	81	0.00
79	88	0.00
70	80	0.02
70	80	0.02
70	74	0.02

Temperatures for the continental U.S. at FL480 for 1200 UTC on 9 September 2005:

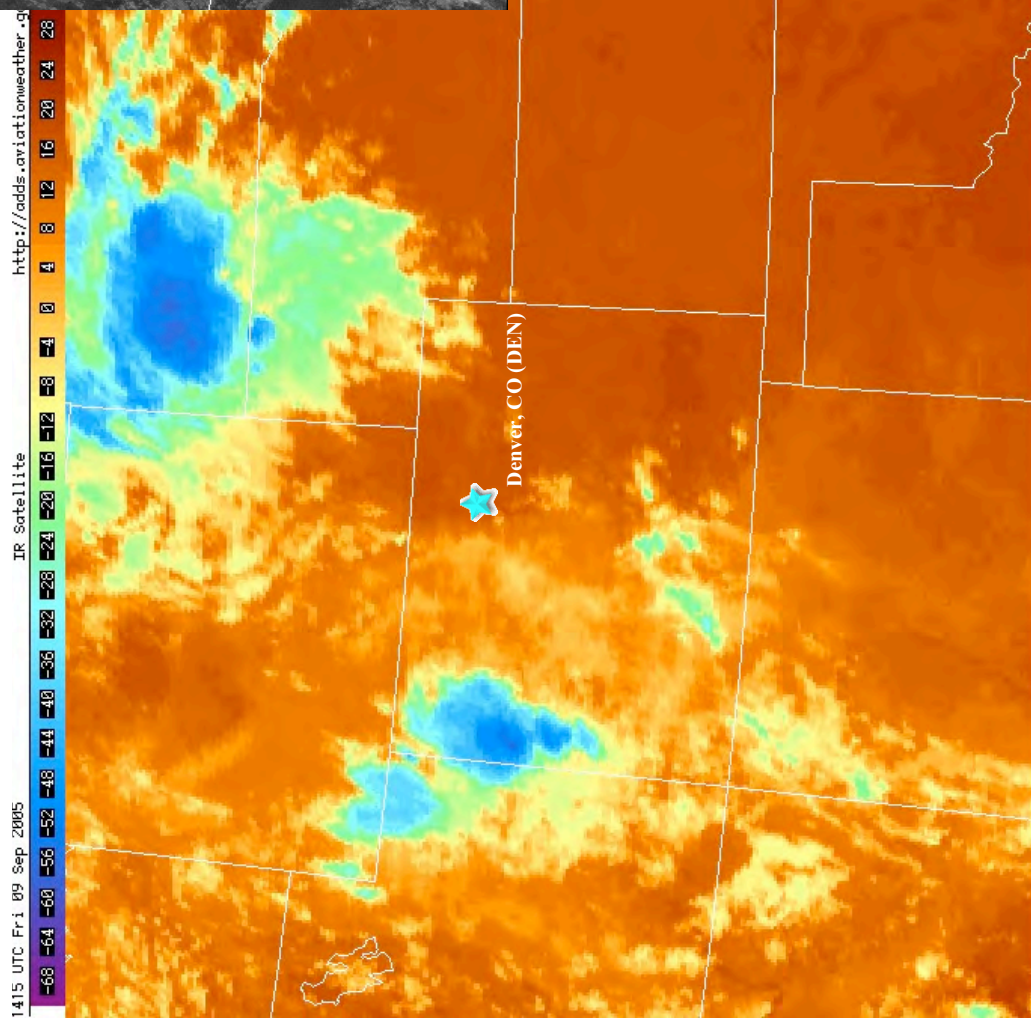
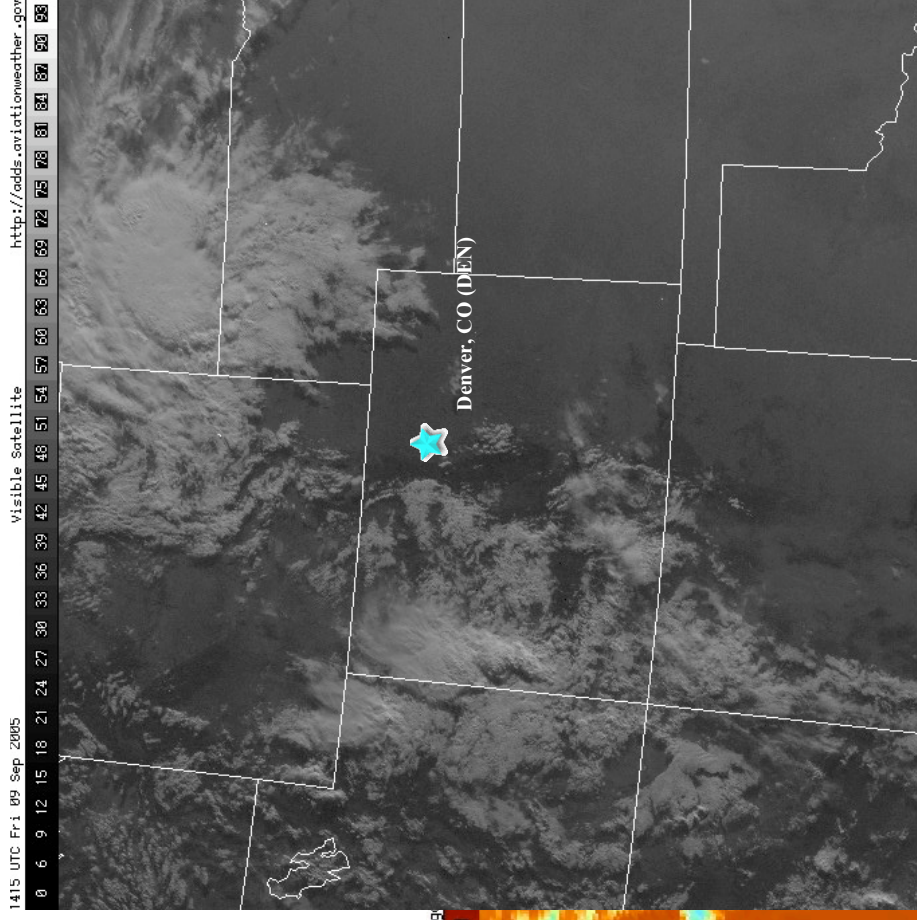
**Temperatures at FL480 over the Denver/Kansas City flight area are approximately -60 degrees Celsius.**

**Temperature (°C) at 48,000 ft MSL (125 mb)**



Visible Satellite Image over Denver, CO  
at 1415 UTC on 9 September 2005:

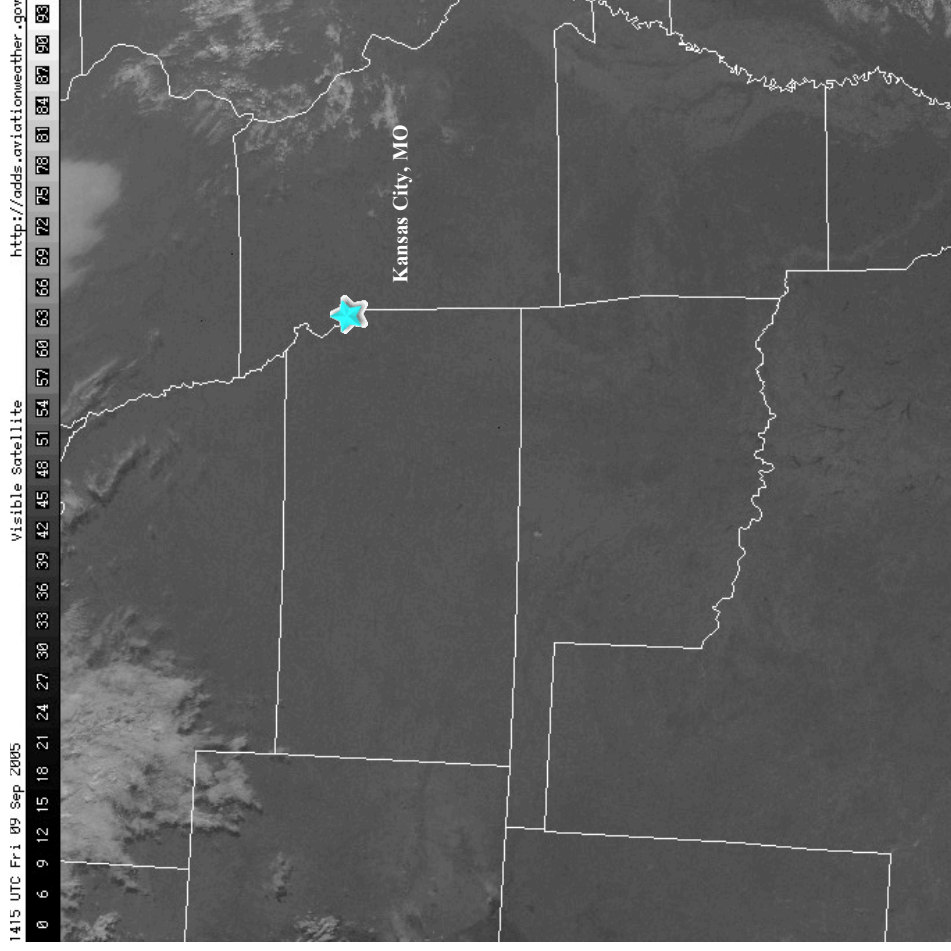
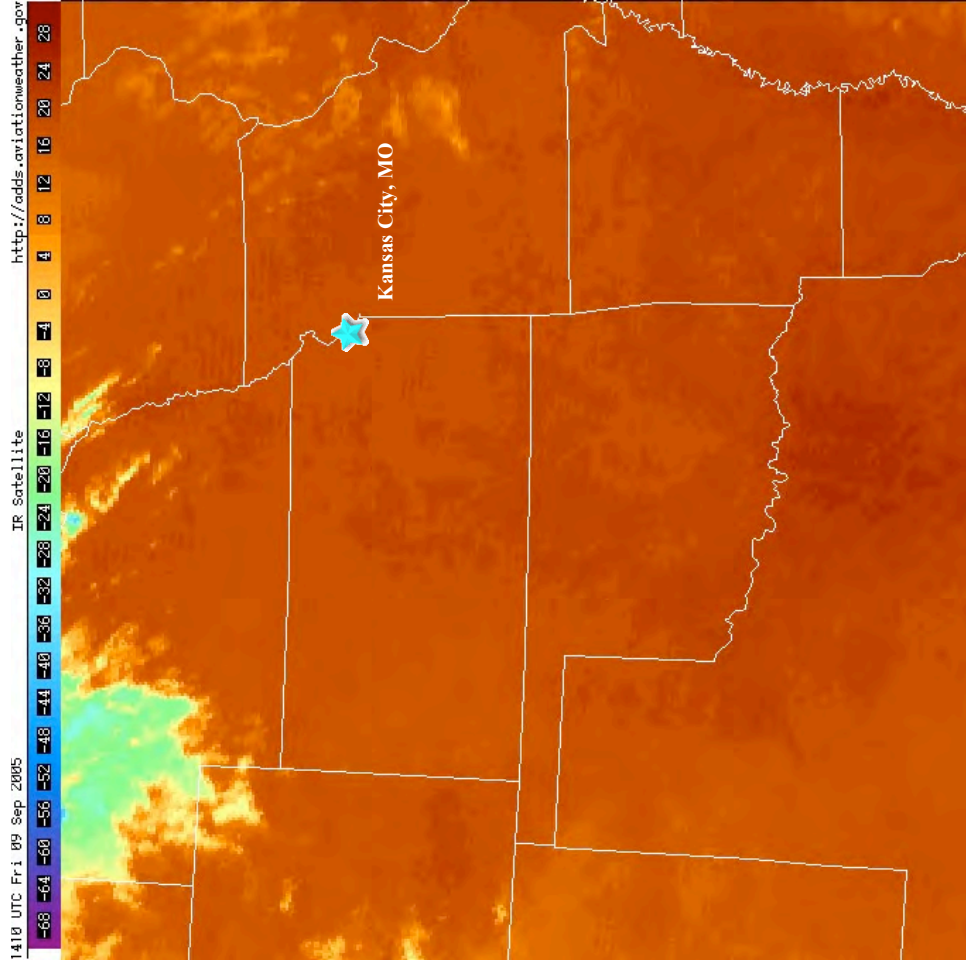
There are thunderstorms along the  
western border of Colorado. There  
are also thunderstorms in western  
Nebraska.



Infrared Satellite Imagery over  
Denver, CO at 1415 UTC on 9  
September 2005:

Visible Satellite Imagery over  
Kansas City, MO at 1415 UTC  
on 9 September 2005:

The skies are clear  
over this area.

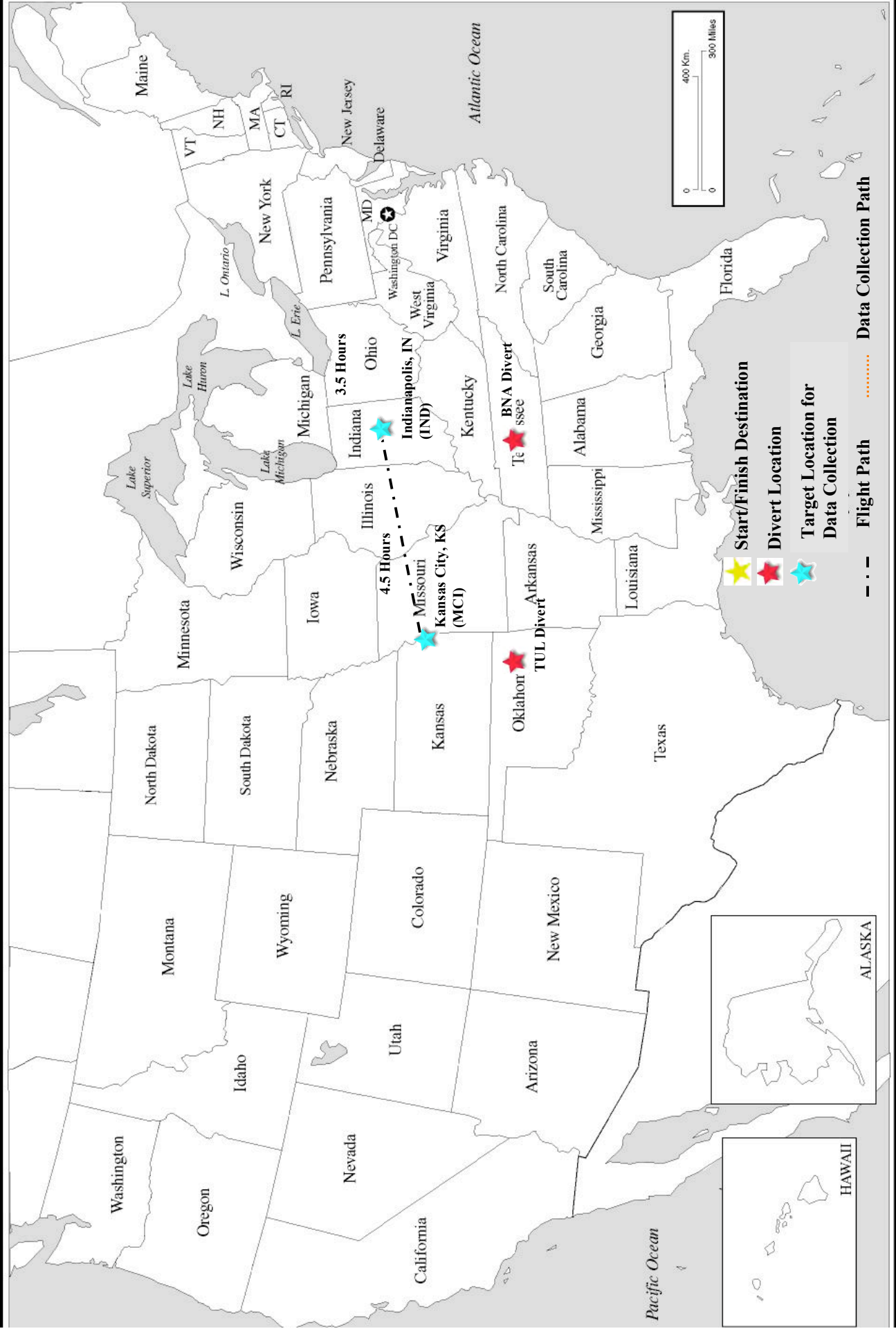


Clear skies are depicted  
from this image as well as  
the visible.



Infrared Satellite Imagery over  
Kansas City, MO at 1410 UTC  
on 9 September 2005:

# Flight Scenario Second Leg



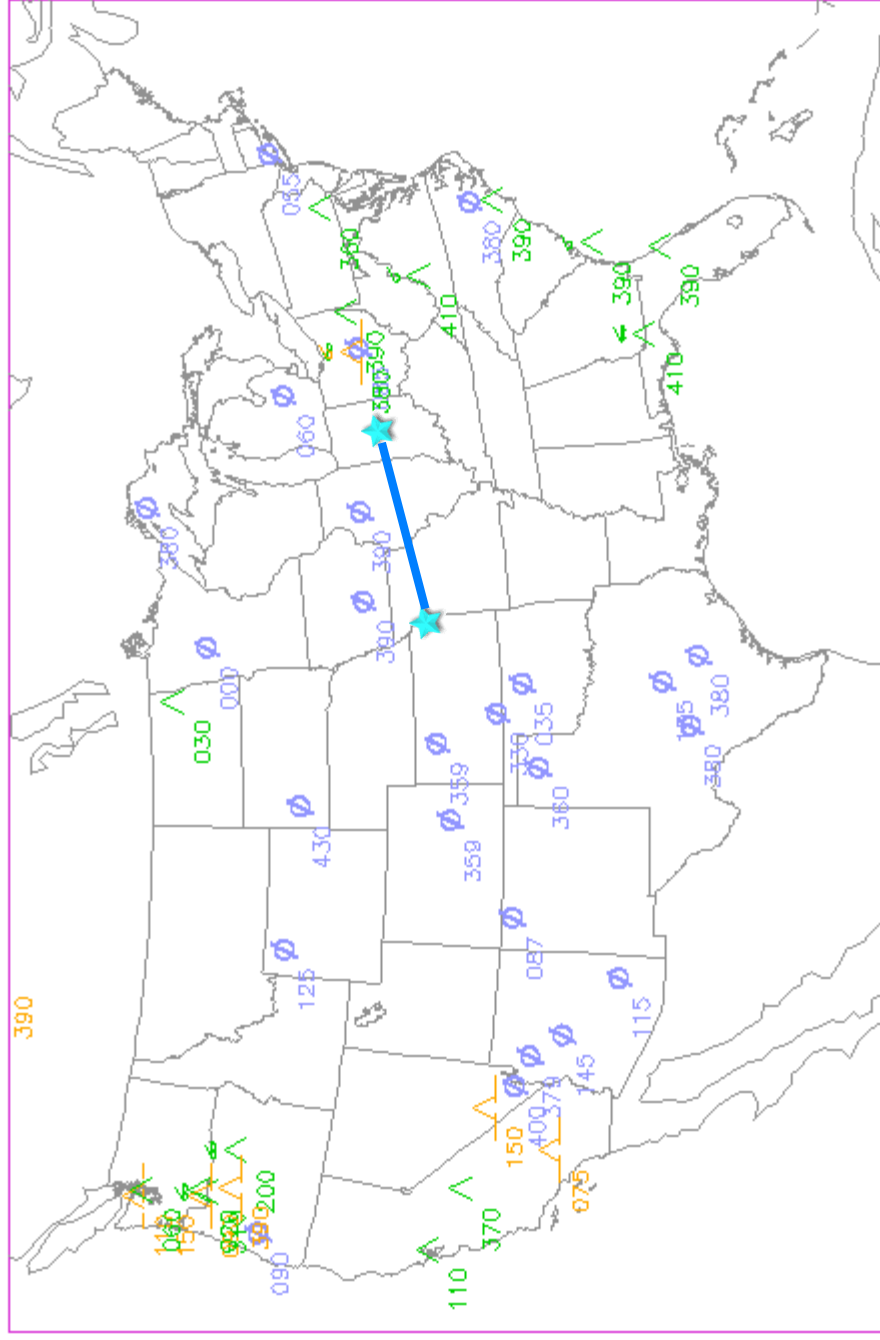
PIREP of turbulence for 1430 UTC  
on 9 September 2005 across the  
continental U.S.:

**Ending data collection  
from Denver, CO to  
Kansas City, MO.**

**Heading from Kansas  
City to Indianapolis, IN,  
arriving in Indianapolis  
at 1900 UTC on 9  
September 2005.**

# Pilot Reports (PIREPs) of Turbulence

1259z – 1425z 09/09/05



1430 09/09/05

TB FREQUENCY:  $\phi$  = ISOLATED  $\phi$  = INTERMITTENT  $\phi$  = CONTINUOUS

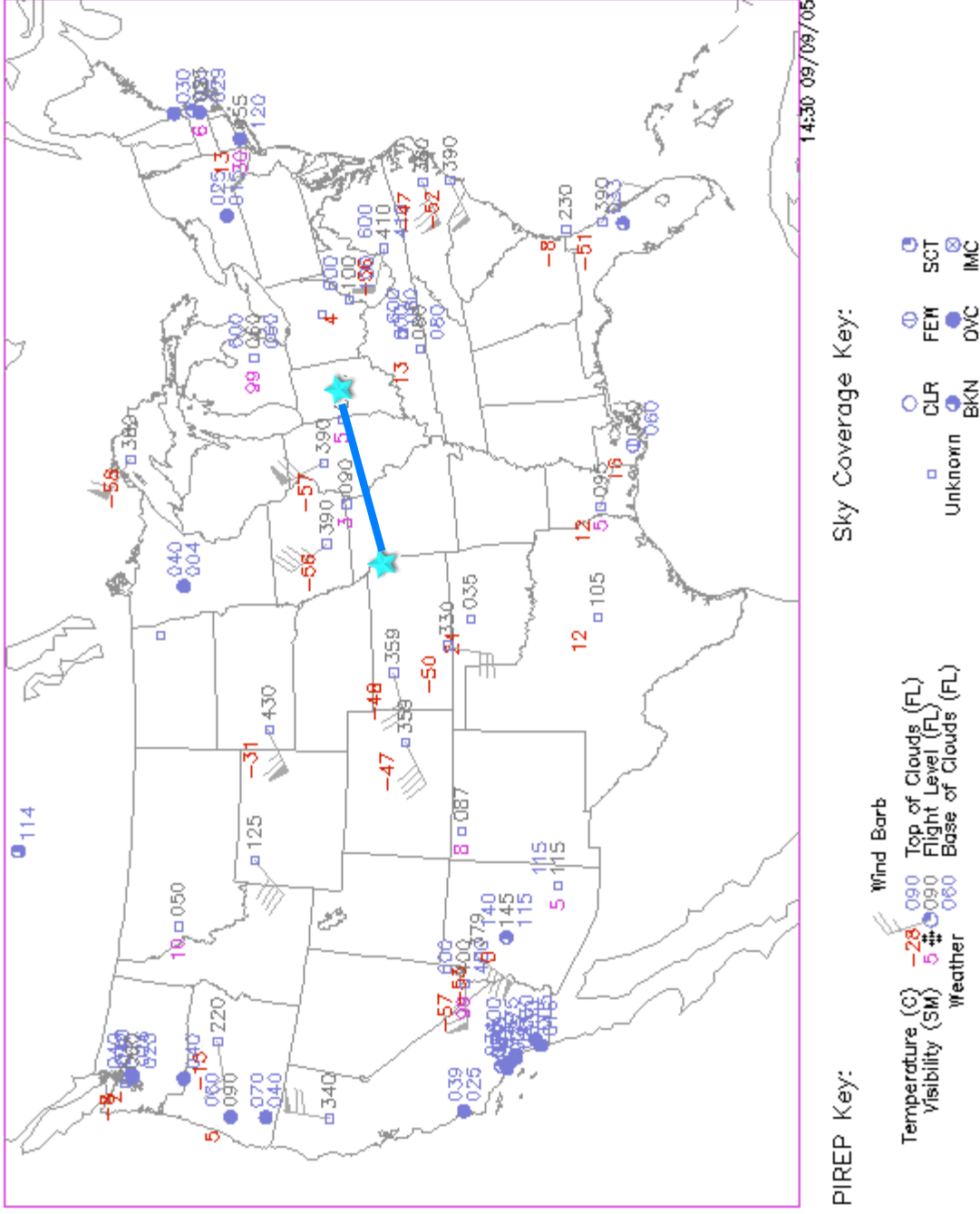
$\phi$  NEG  $\phi$  LGT  $\phi$  MOD  $\phi$  SEV  $\phi$  EXTRM

--- SMOOTH-LGT  $\phi$  LGT-MOD  $\phi$  MOD-SEV  $\phi$  EXTRM

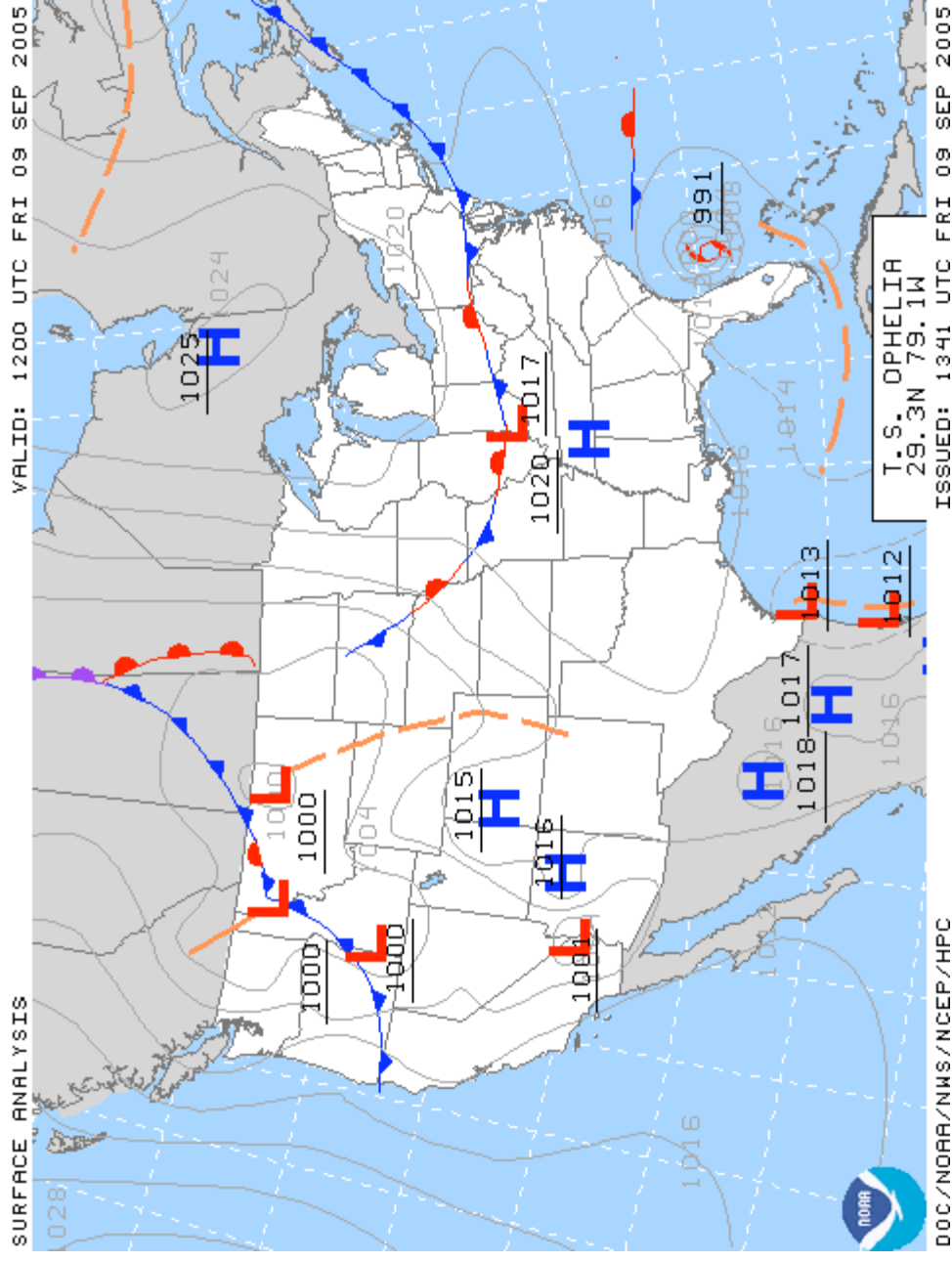
**PIREP of Weather and condition for 1430 UTC 9 September 2005:**

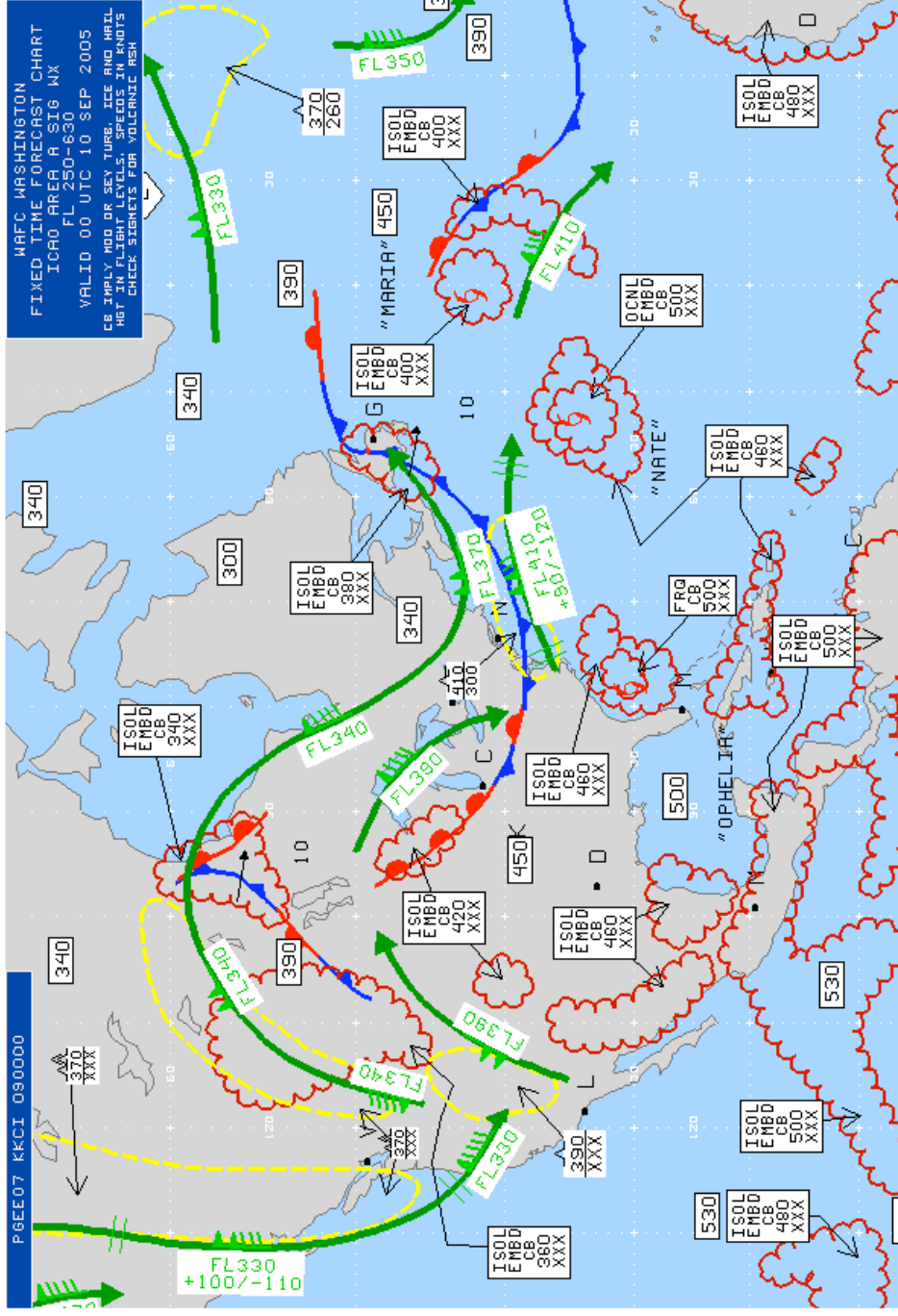
Pilot Reports (PIREPs) of Weather and Sky Conditions

1258z - 1426z 09/09/05



**Surface Analysis Chart for  
potential diverts/contingency  
management valid 1200 UTC on 9  
September 2005:**





**Current Time approximately 1451 UTC.**

**Flight status: en route from Kansas City, MO to Indianapolis, IN orbit point.**

**Estimated time of arrival: 1900 UTC**

**Turbulence of light intensity or less is expected along the flight path.**

Turbulence AIRMETs (green) and SIGMETs (red)

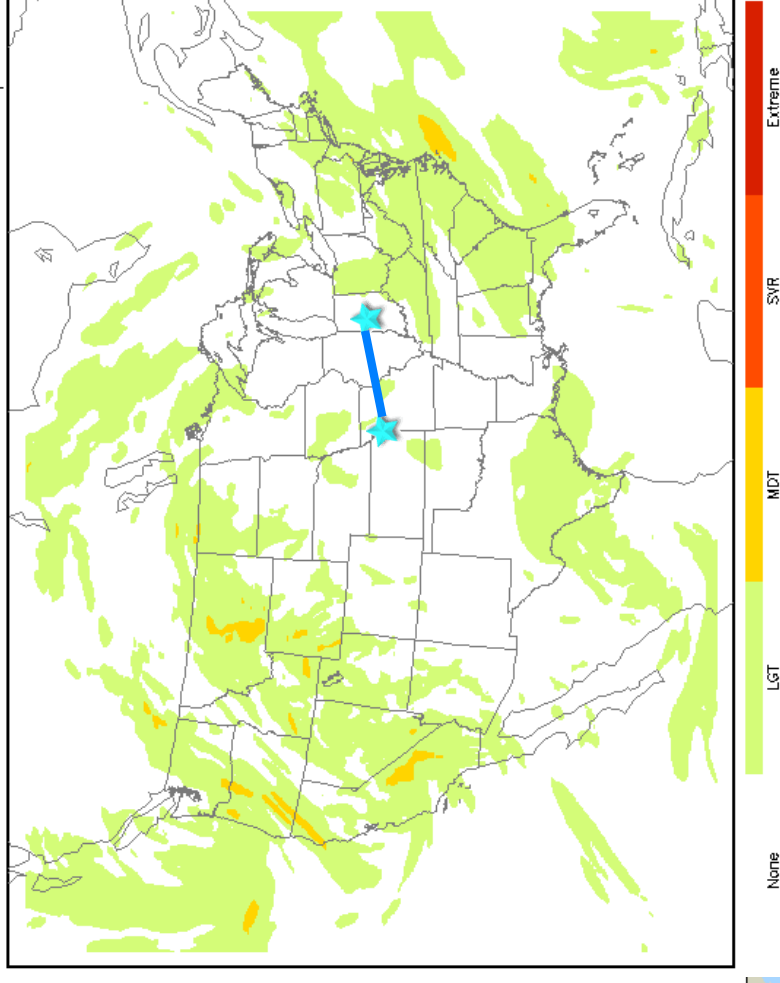
chart created at 1355 UTC Fri 09 Sep 2005

AIRMETs valid until 2000z/9<sup>h</sup>, SIGMETs expire at or before 1555z/9<sup>h</sup>



**Turbulence forecast at FL450**

06 hr forecast valid 1800 UTC Fri 09 Sep 2005

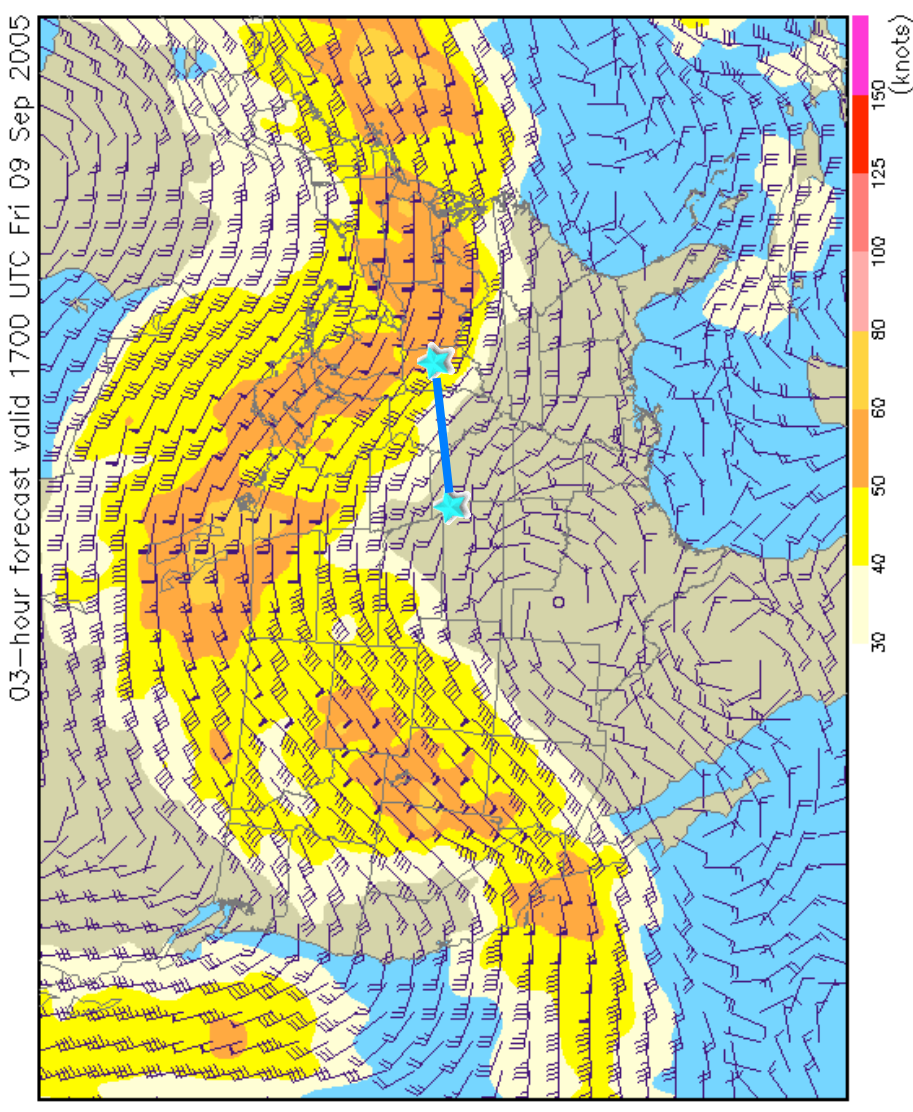


**Turbulence AIRMETs and SIGMETs reported for 1400 UTC on 9 September 2005 valid until 2000 UTC on 9 September 2005.**

Wind speed at FL480 valid  
until 1700 UTC on 9  
September 2005:

**Winds associated with a  
jet stream are over the  
Indianapolis area. The  
winds in this area are 45-  
55 knots from the  
northwest.**

**Wind speed (kts) at 48,000 ft MSL (125 mb)**



Temperature forecast for FL480  
valid at 1700 UTC on 9  
September 2005:

**Flight level temperature forecast  
of -60°C or less for the entire  
mission.**

**Temperature (°C) at 48,000 ft MSL (125 mb)**

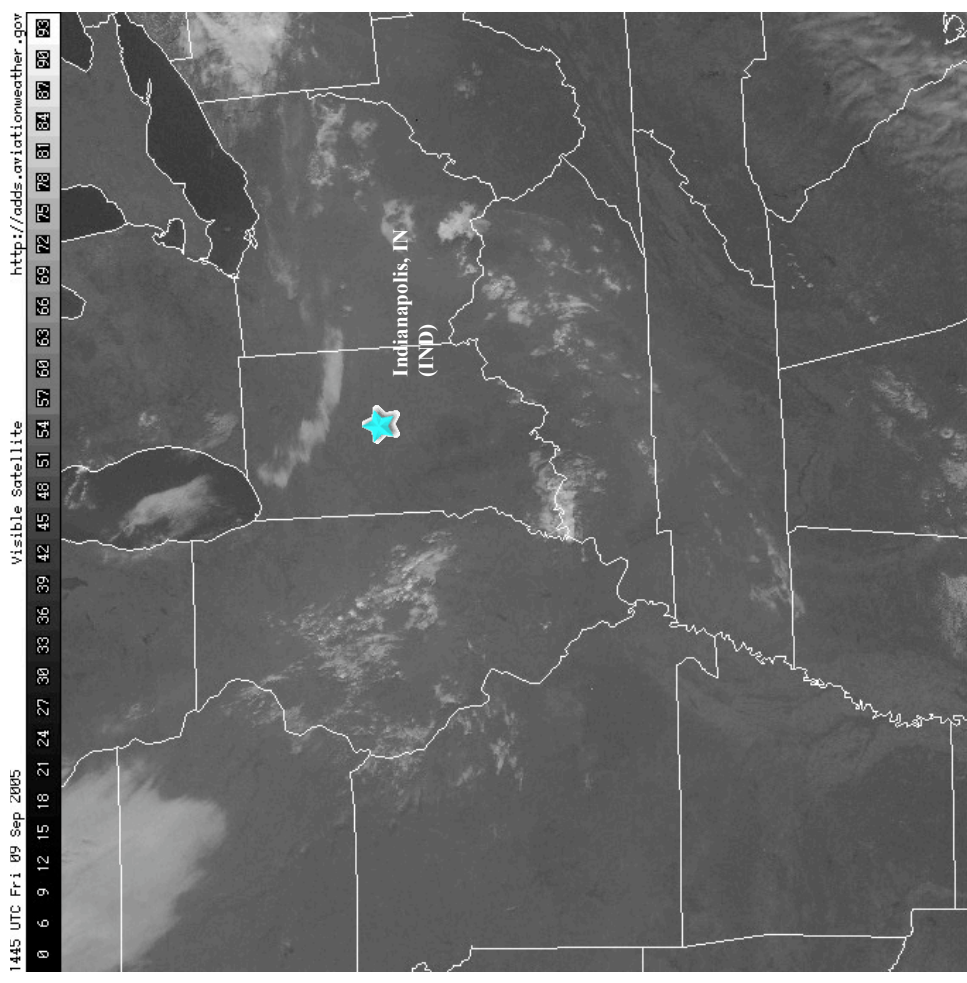
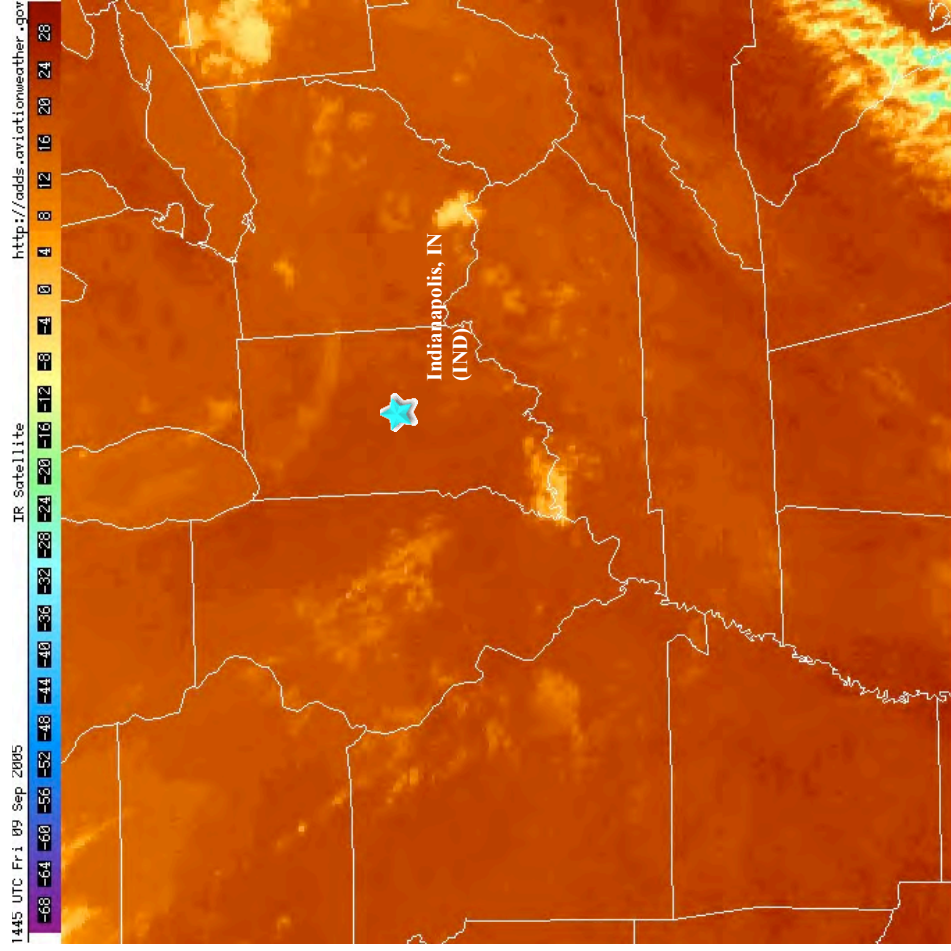
03-hour forecast valid 1700 UTC Fri 09 Sep 2005



## Visible Satellite Imagery of the Indianapolis Area:



**There is no significant weather in the area at this time.**



**Infrared Satellite Imagery of the Indianapolis area:**





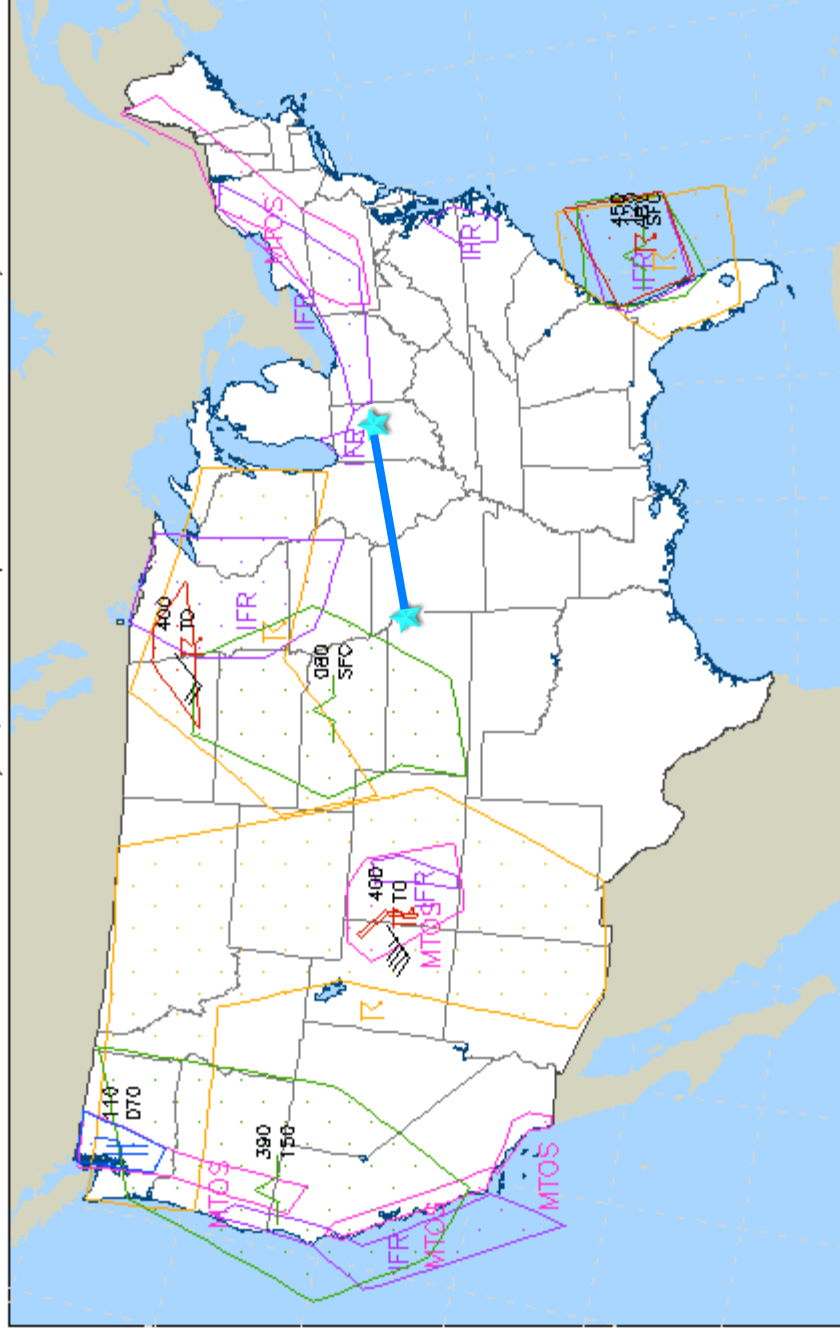
All active AIRMETs and SIGMETs  
valid at 1500 UTC and until  
UTC on 9 September 2005:

**There are no valid  
AIRMETs and  
SIGMETs for this  
leg of the flight.**

All active AIRMETs and SIGMETs

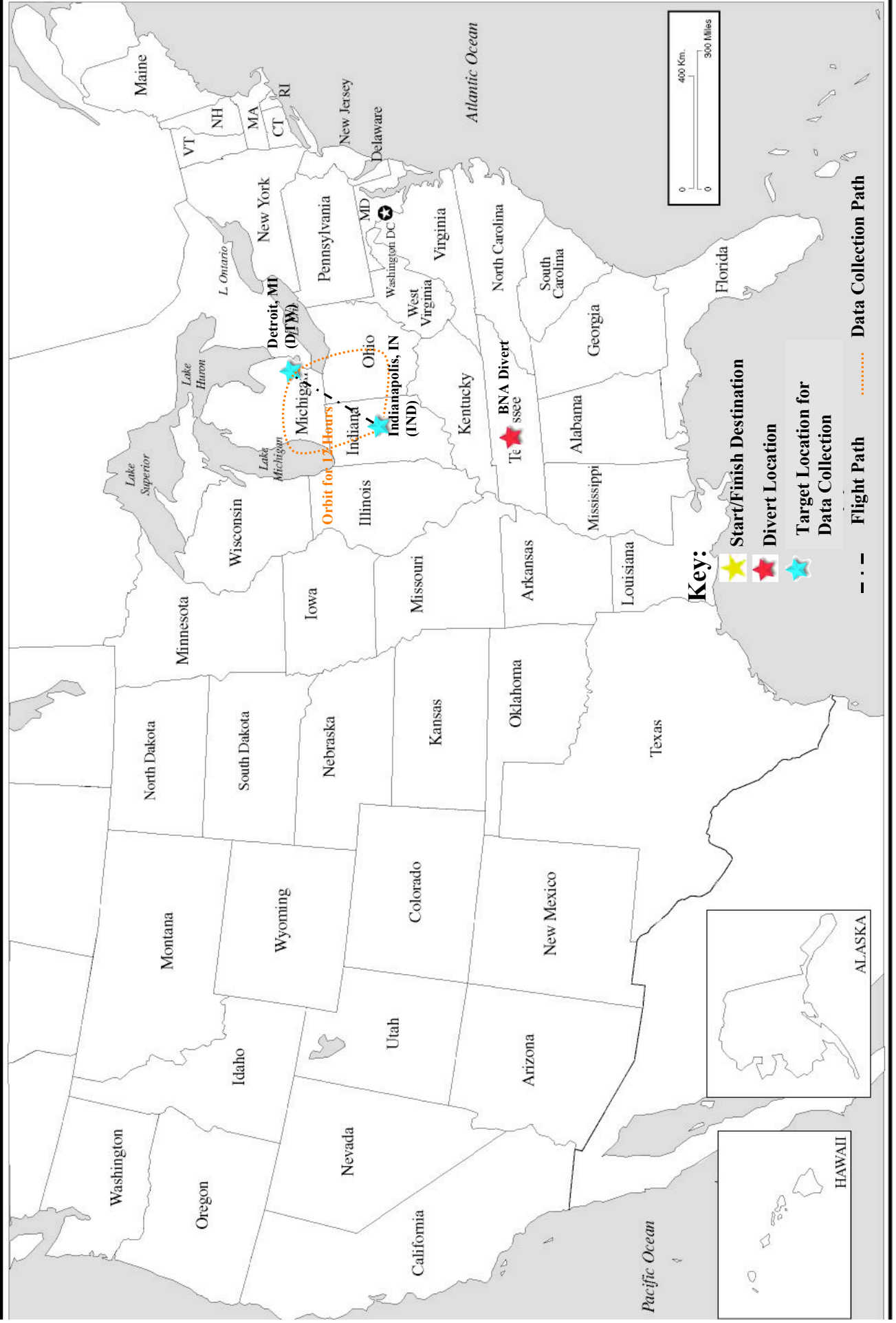
chart created at 1456 UTC Fri 09 Sep 2005

AIRMETs valid until 2000z/g<sup>h</sup>, SIGMETs expire at or before 1655z/g<sup>h</sup>



-  Turbulence AIRMET
-  Icing AIRMET
-  IFR Instrument Flight Rules AIRMET
-  MTOS Mountain Obscuration AIRMET
-  Convective Outlook
-  Convective SIGMET

# Flight Scenario Second Orbit Area

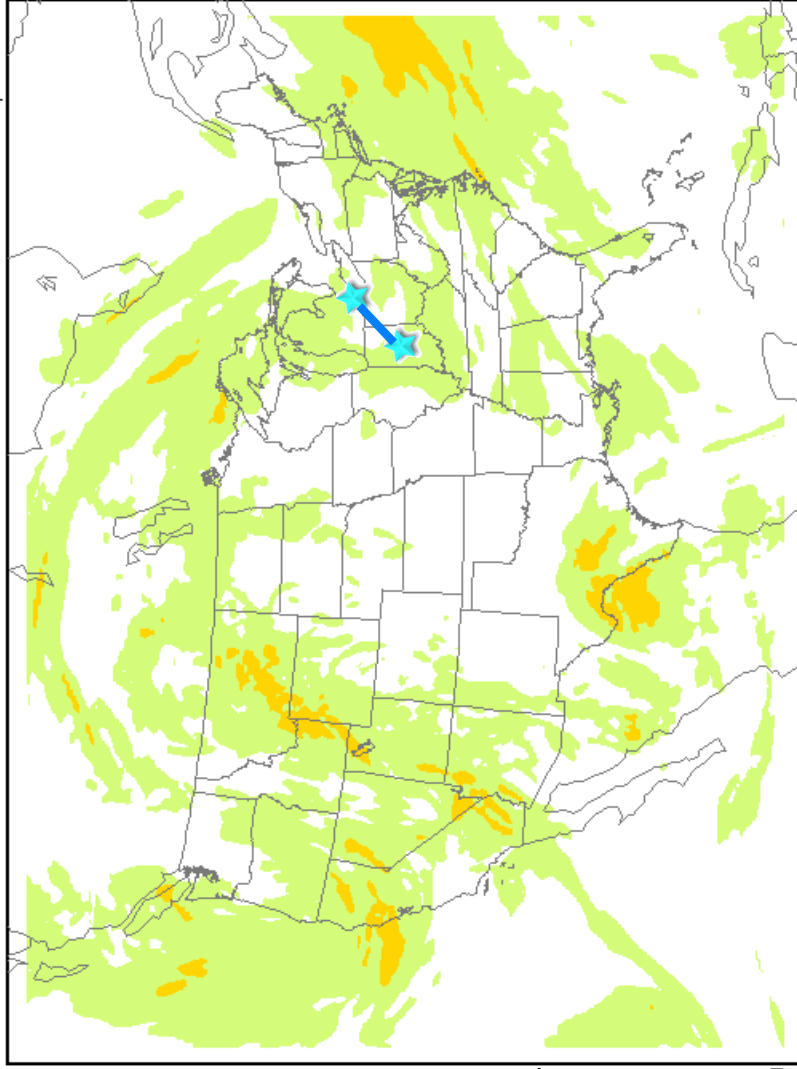


**Arrived at Indianapolis, IN  
headed to Detroit, MI:**

**Estimated time of arrival in  
Detroit, MI is 2230 UTC on 9  
September 2005**

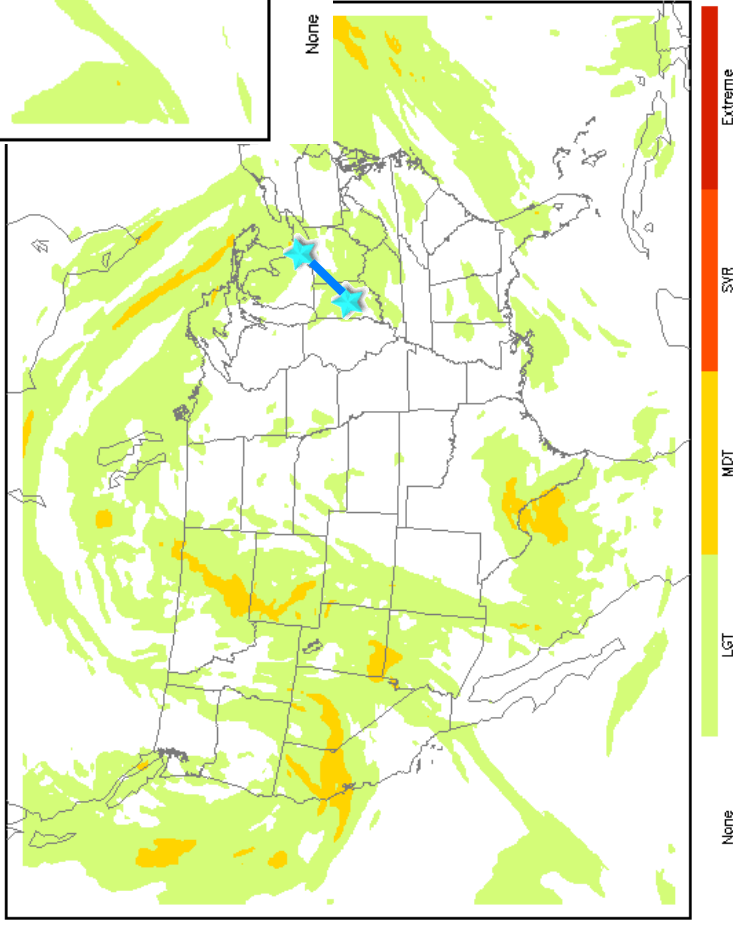
**Turbulence forecast at FL450**

09 hr forecast valid 0300 UTC Sat 10 Sep 2005



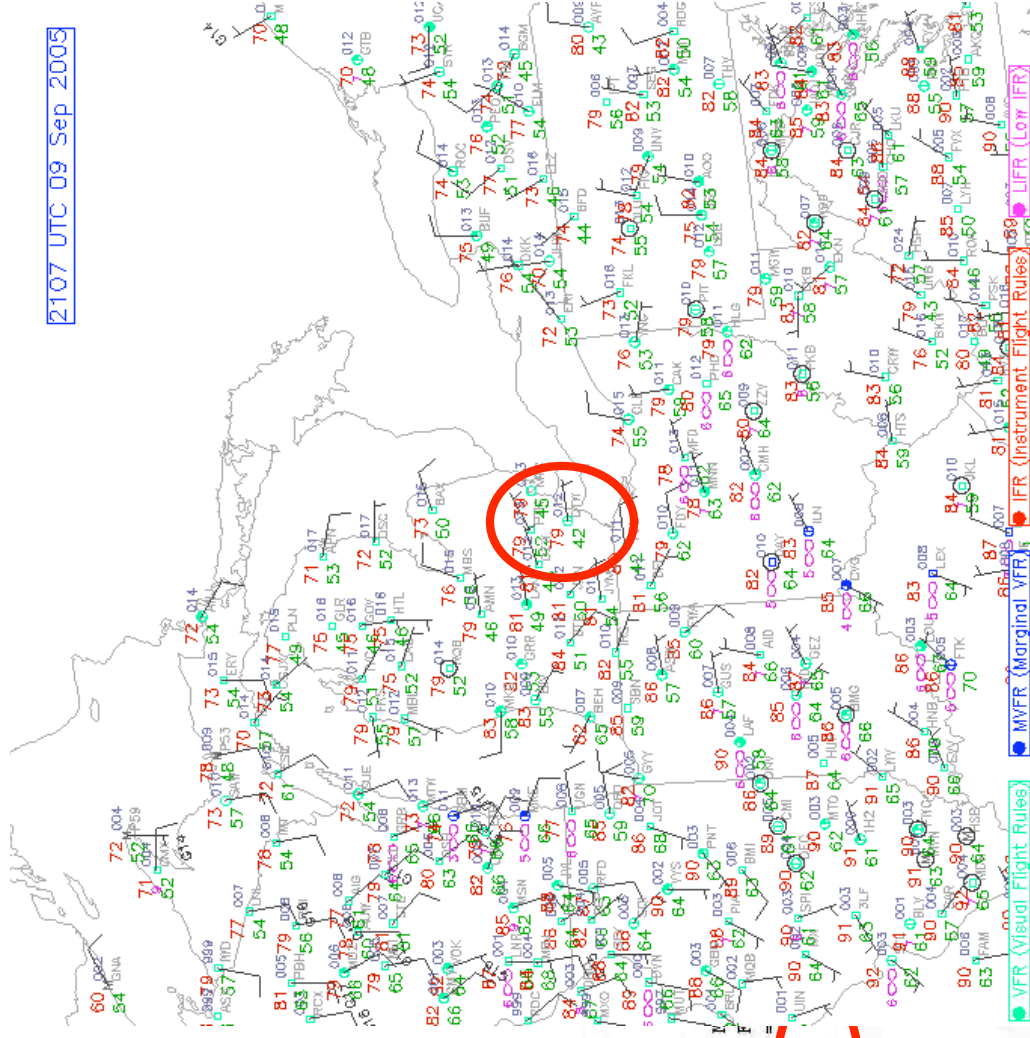
**Turbulence forecast at FL450**

12 hr forecast valid 0600 UTC Sat 1



**Turbulence of light  
intensity or less is  
expected along the flight  
path.**

2107 UTC 09 Sep 2005



- VFR (Visual Flight Rules)

- MVFR (Marginal VFR)

IFR {Instrument Fli

Light Rules

by IFR

## Observations for DETROIT, MI (DET)

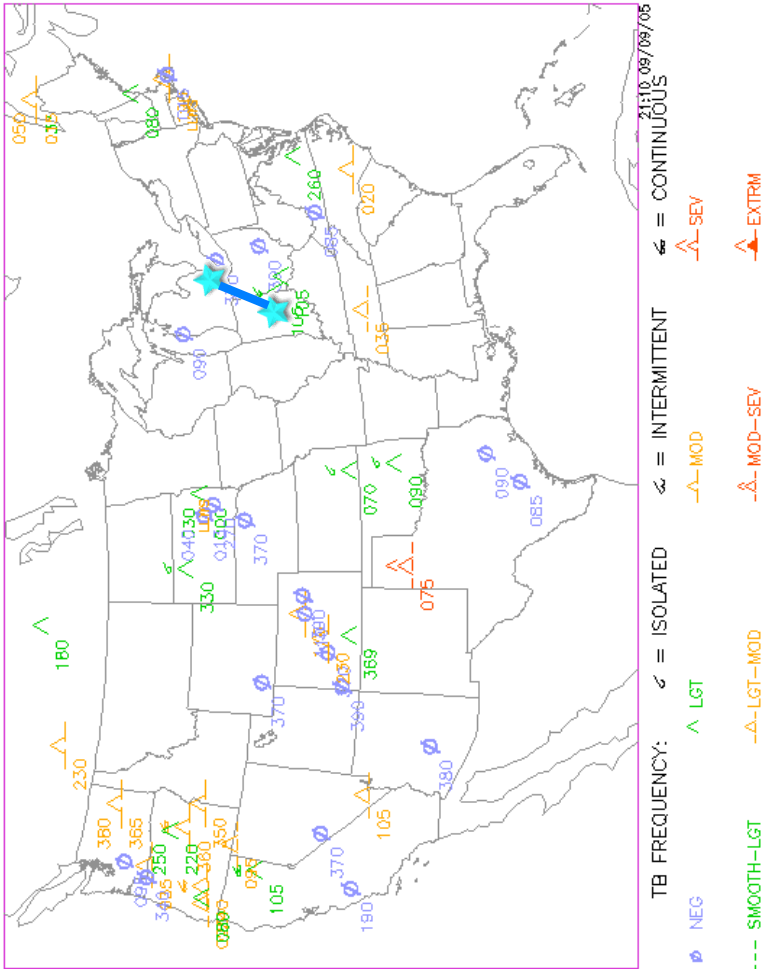
1853Z 8 Sep 2005 to 1953Z 9 Sep 2005

STN	TIME	PNSL	ALTM	TMP	DEW	RH	DIR	SPD	VIS	CLOUDS
DD/HHMM	hrPa	inHg	F	F	%	deg	kt	mi	%	
DET	09/1953	1020.4	30.14	79	48	34	120	9	10	CLR
DET	09/1853	1021.0	30.16	78	47	33	30	6	10	CLR
DET	09/1753	1021.1	30.16	76	49	39	70	9	10	CLR
DET	09/1653	1021.7	30.18	75	48	38	30	11	10	CLR
DET	09/1553	1022.0	30.19	73	48	41	60	8	10	CLR
DET	09/1453	1022.1	30.19	72	49	44	40	5	10	CLR
DET	09/1353	1021.9	30.19	70	50	49	50	7	10	CLR
DET	09/1253	1021.5	30.17	67	54	63	40	4	10	CLR
DET	09/1153	1021.2	30.16	62	54	75	360	4	10	CLR
DET	09/1053	1020.5	30.14	62	53	72	360	4	10	CLR
DET	09/0953	1019.9	30.13	63	54	72	0	0	10	CLR
DET	09/0853	1019.4	30.11	63	54	72	30	5	10	FEW120
DET	09/0753	1019.5	30.12	65	53	65	0	0	10	FEW110
DET	09/0653	1019.3	30.11	67	54	63	10	4	10	CLR
DET	09/0553	1019.5	30.11	65	54	68	360	5	10	CLR
DET	09/0453	1019.4	30.11	66	54	65	10	5	10	CLR
DET	09/0353	1019.6	30.12	66	55	68	40	3	10	CLR
DET	09/0253	1019.5	30.11	67	55	66	30	6	10	CLR
DET	09/0153	1019.6	30.12	68	53	59	20	10	10	CLR
DET	09/0053	1018.9	30.10	69	58	68	50	9	10	CLR
DET	08/2353	1018.4	30.08	72	60	66	80	5	10	CLR
DET	08/2253	1018.1	30.08	74	61	64	100	7	10	CLR
DET	08/2153	1018.1	30.08	74	61	64	110	9	10	CLR
DET	08/2053	1018.5	30.09	75	62	64	60	7	10	CLR
DET	08/1953	1018.0	30.10	75	61	62	70	5	10	FEW070
DET	08/1853	1019.2	30.11	73	62	68	70	8	10	FEW060

# PIREPs summarizing weather and sky conditions over the contiguous United States:

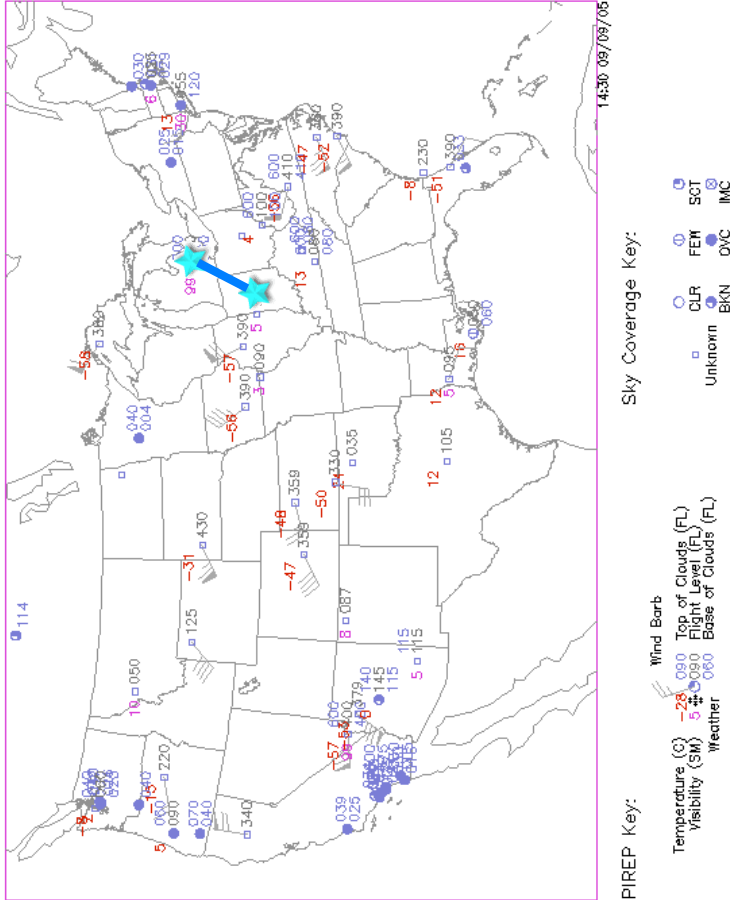
Pilot Reports (PIREPs) of Turbulence

1939z - 2101z 09/09/05



Pilot Reports (PIREPs) of Weather and Sky Conditions

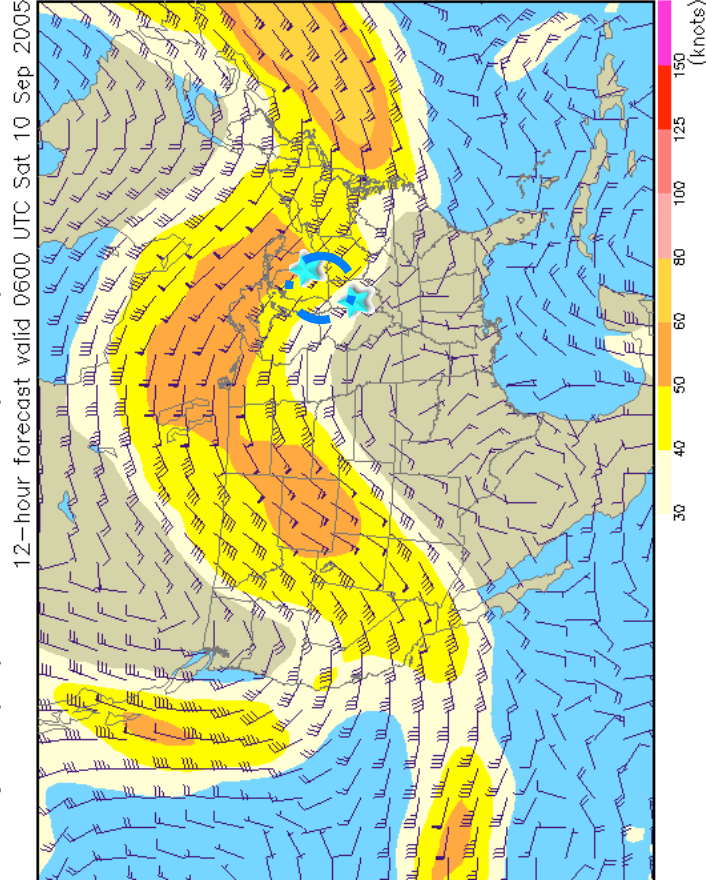
1258z - 1426z 09/09/05



Wind speed forecasts for the Indianapolis/Detroit leg of flight:

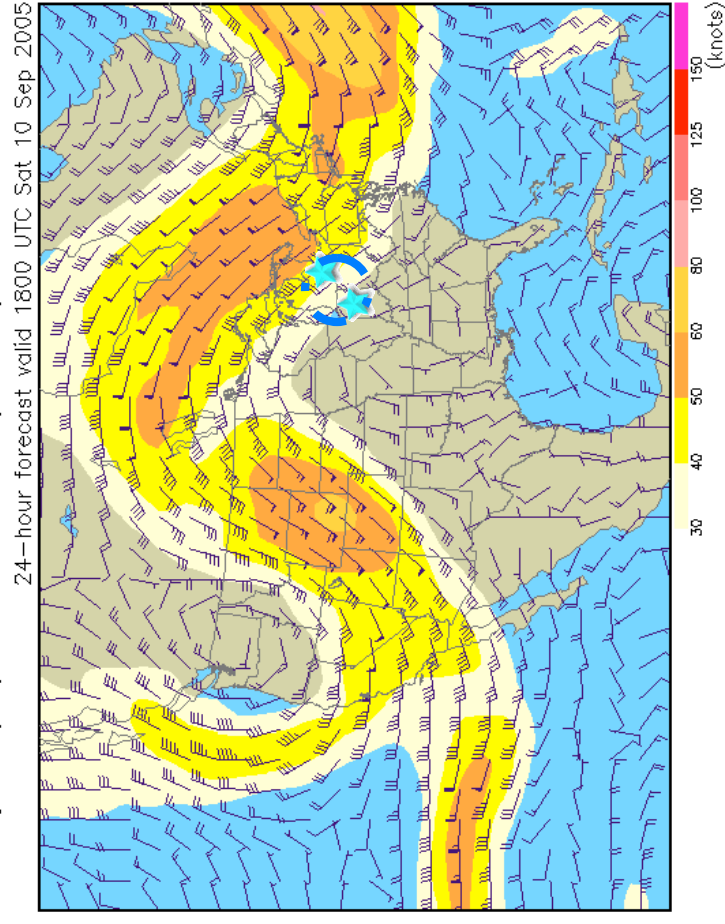
**Begin data collection when arrive in Detroit, MI Orbit for 12 hours from 2230 UTC on 9 September 2005 to 1030 UTC on 10 September 2005.**

**Wind speed (kts) at 48,000 ft MSL (125 mb)**



**Winds for this portion of flight are approximately 30-40 knots from the northwest.**

**Wind speed (kts) at 48,000 ft MSL (125 mb)**



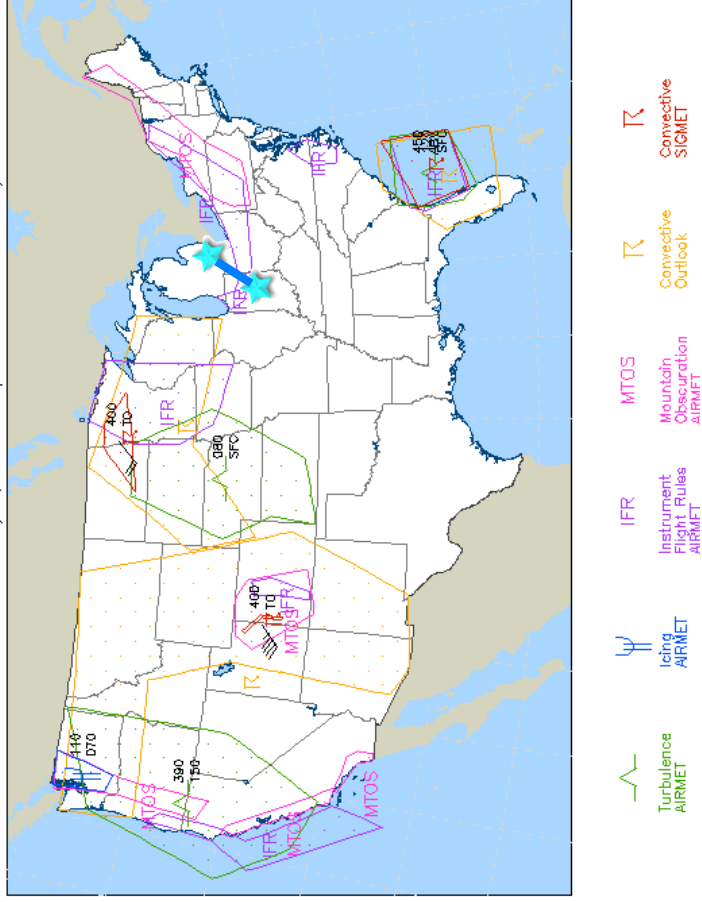
Temperature forecast for FL480 valid 1200 UTC on 10 September 2005.

## Data collection in progress for Detroit/Indianapolis leg of flight.

All active AIRMETs and SIGMETs

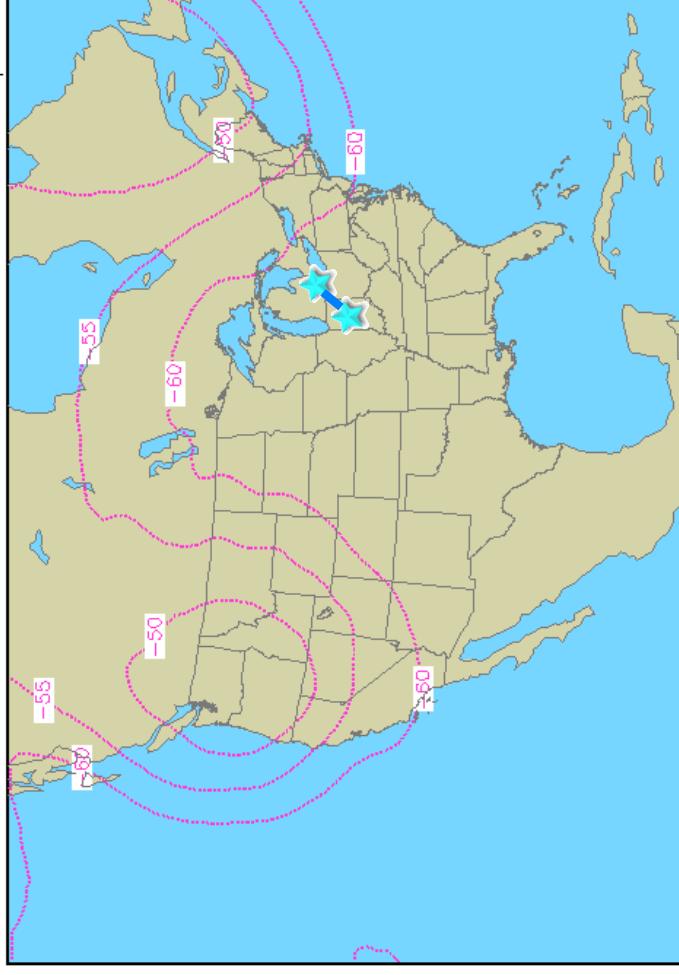
chart created at 1456 UTC Fri 09 Sep 2005

AIRMETs valid until 2000z/9<sup>th</sup>, SIGMETs expire at or before 1655z/9<sup>th</sup>



Temperature (°C) at 48,000 ft MSL (125 mb)

18-hour forecast valid 1200 UTC Sat 10 Sep 2005

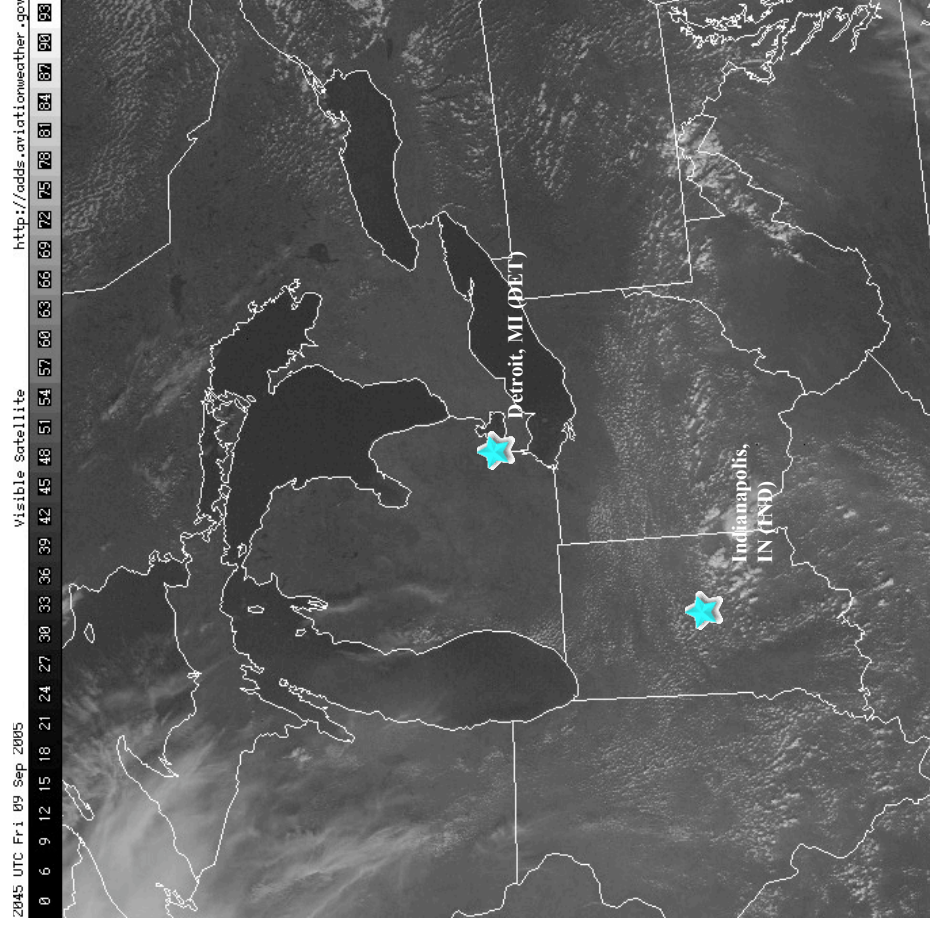


All active AIRMETs and SIGMETs valid 1456 UTC on 9 September 2005.

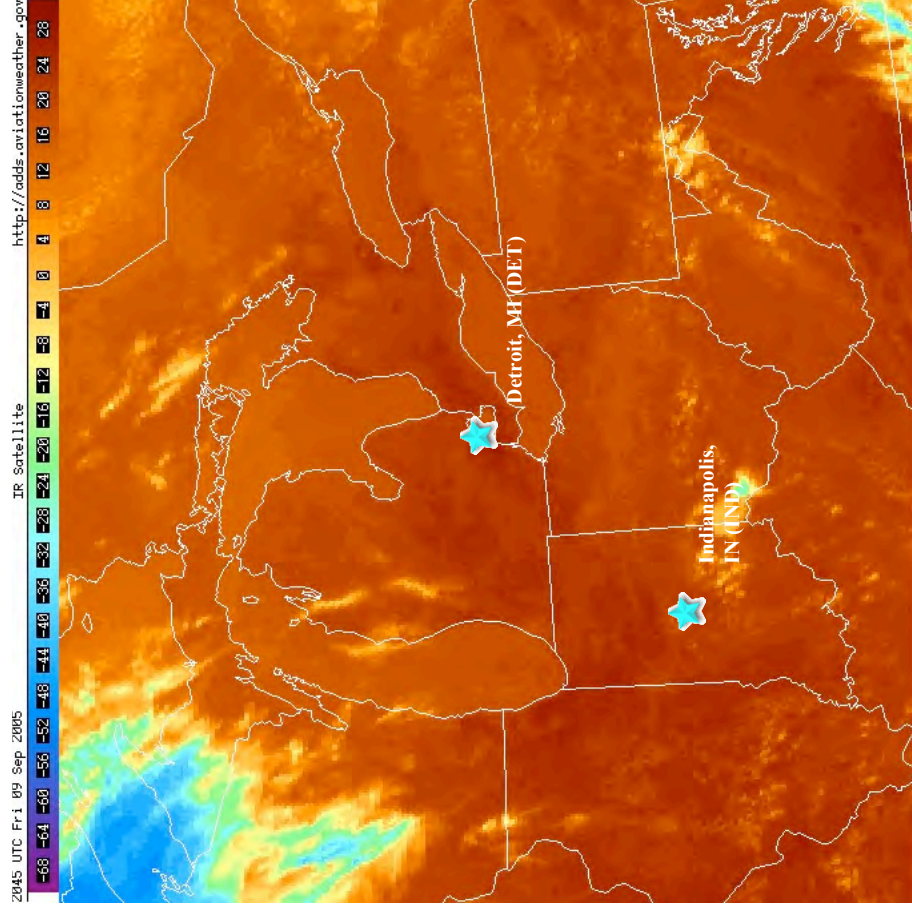
AIRMETs are valid until 2000 UTC on 9 September 2005.

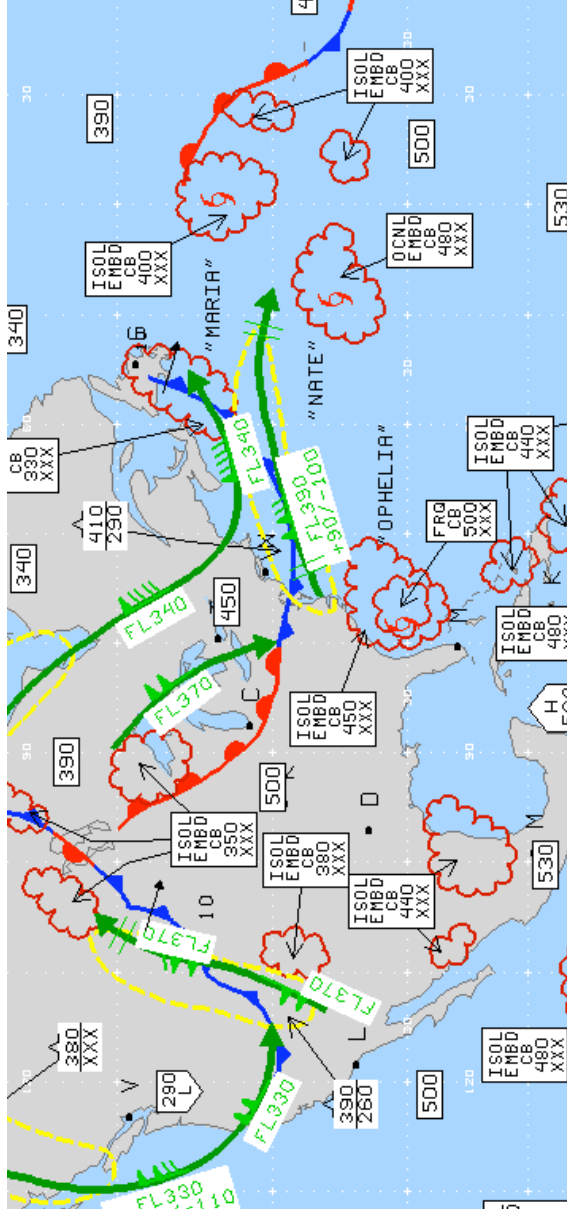
SIGMETs expire at 1655 UTC on 9 September 2005.

## Visible and IR imagery for the Detroit/Indianapolis area:

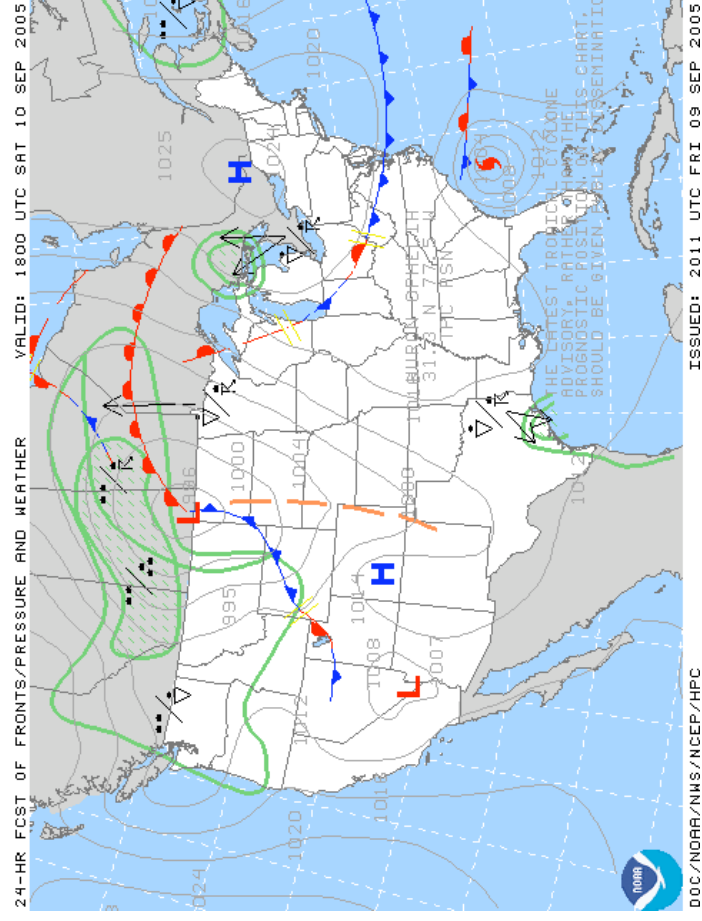
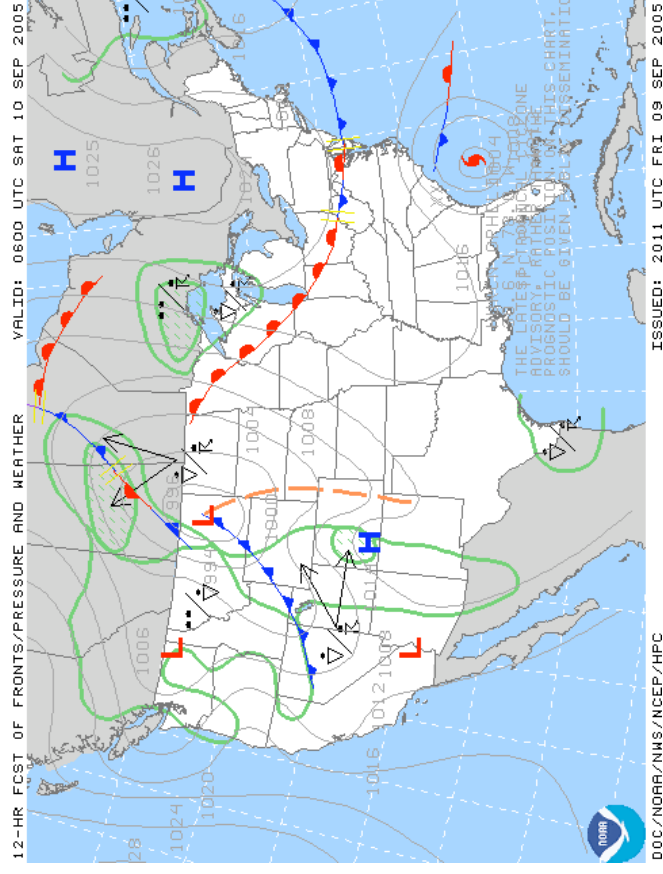


**No significant weather for this  
area.**





# **12 hour and 24 hour surface level forecasts valid until 0600 UTC and 1800 UTC respectively on 10 September 2005.**





**Current Time: approximately 1500 UTC on 10 September 2005**

On Final approach from Detroit, MI to Andrew's AFB.

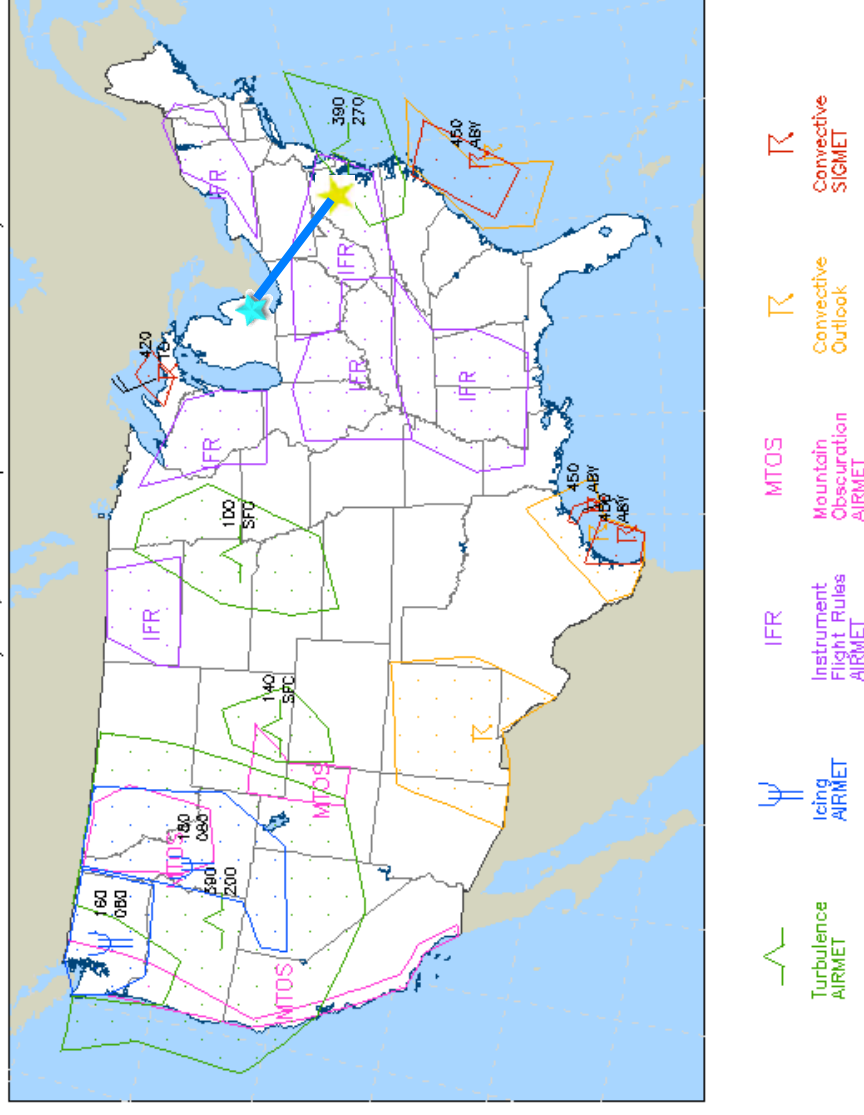
**For this area there is an Instrument Flight Rules AIRMET valid during descent and landing/planned arrival time.**

**There is also a turbulence AIRMET in effect near the Andrews AFB area. The turbulence AIRMET is effecting flight between 27,000 to 39,000 feet. The pilot should be aware of both notifications for descent into Andrews.**

All active AIRMETs and SIGMETs

chart created at 1338 UTC Sat 10 Sep 2005

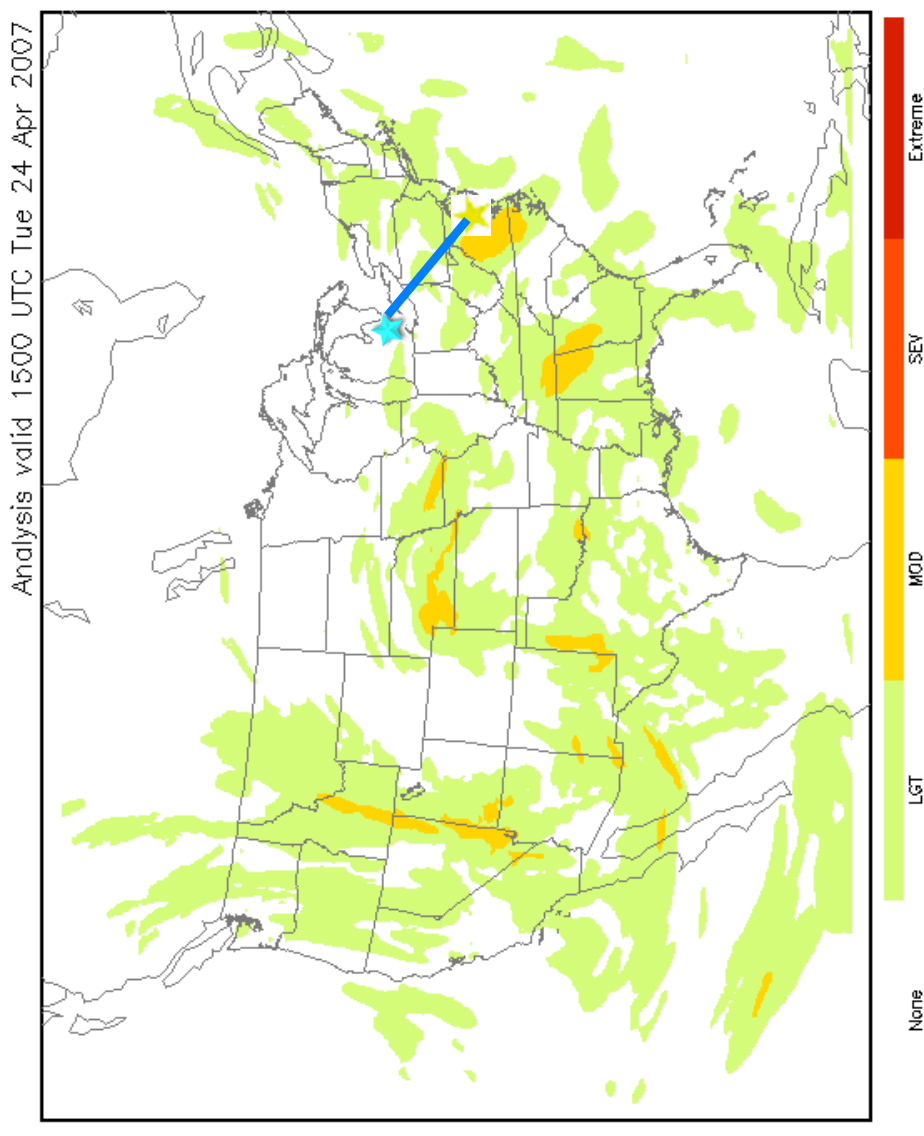
AIRMETs valid until 1400z/10<sup>th</sup>, SIGMETs expire at or before 1455z/10<sup>th</sup>



Turbulence forecast at FL450 valid  
1200 UTC on 10 September 2005:

**Map shows light turbulence  
or less enroute from  
Detroit to Andrews AFB  
with some areas of  
moderate turbulence just  
south of Andrews AFB.**

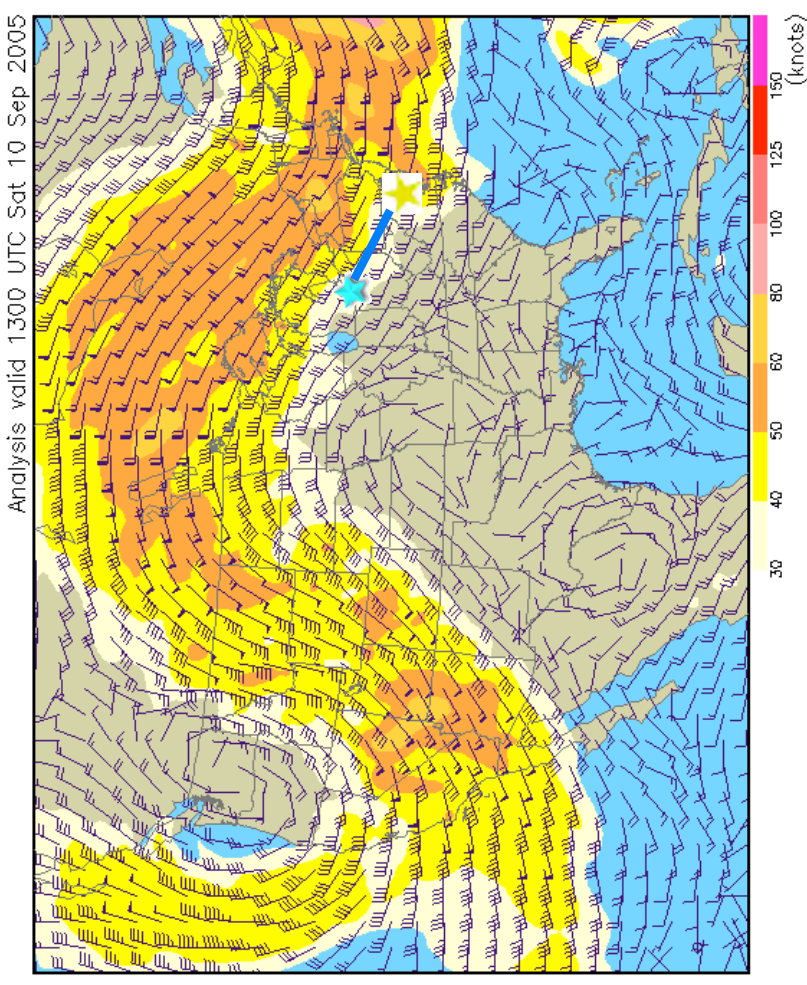
### **Turbulence forecast at FL450**



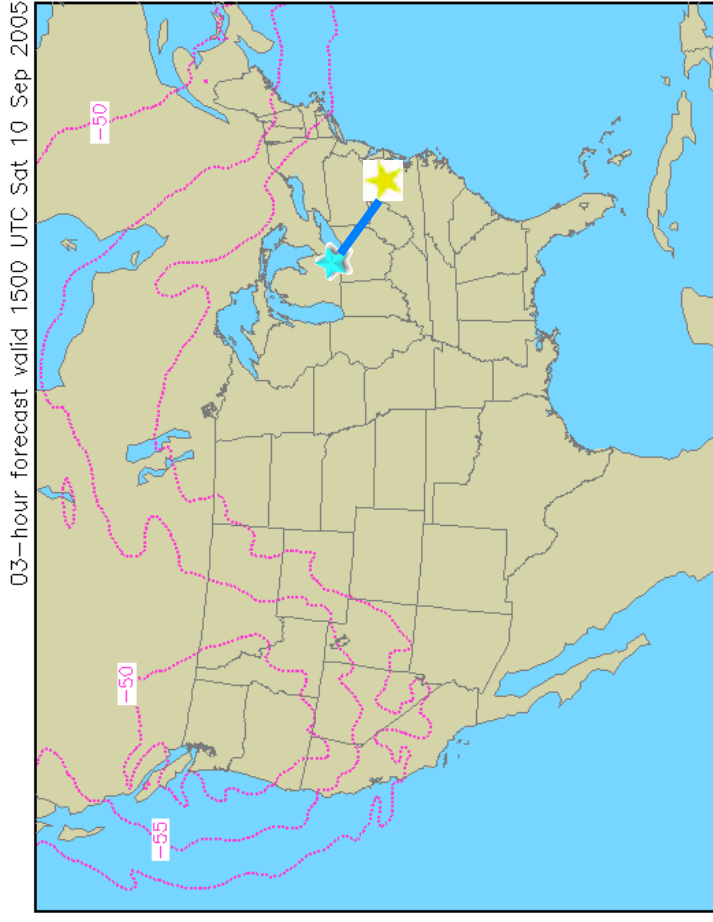
Wind speeds at 1300 UTC on 10 September 2005 for FL480.

The plane will be flying in the jet stream from Detroit to Andrews AFB with winds around 30-40 knots.

Wind speed (kts) at 48,000 ft MSL (125 mb)



Temperature (°C) at 48,000 ft MSL (125 mb)



Temperatures at FL480 valid 1500 UTC on 10 September 2005.

Temperatures at this time are approximately -60 degrees Celsius.

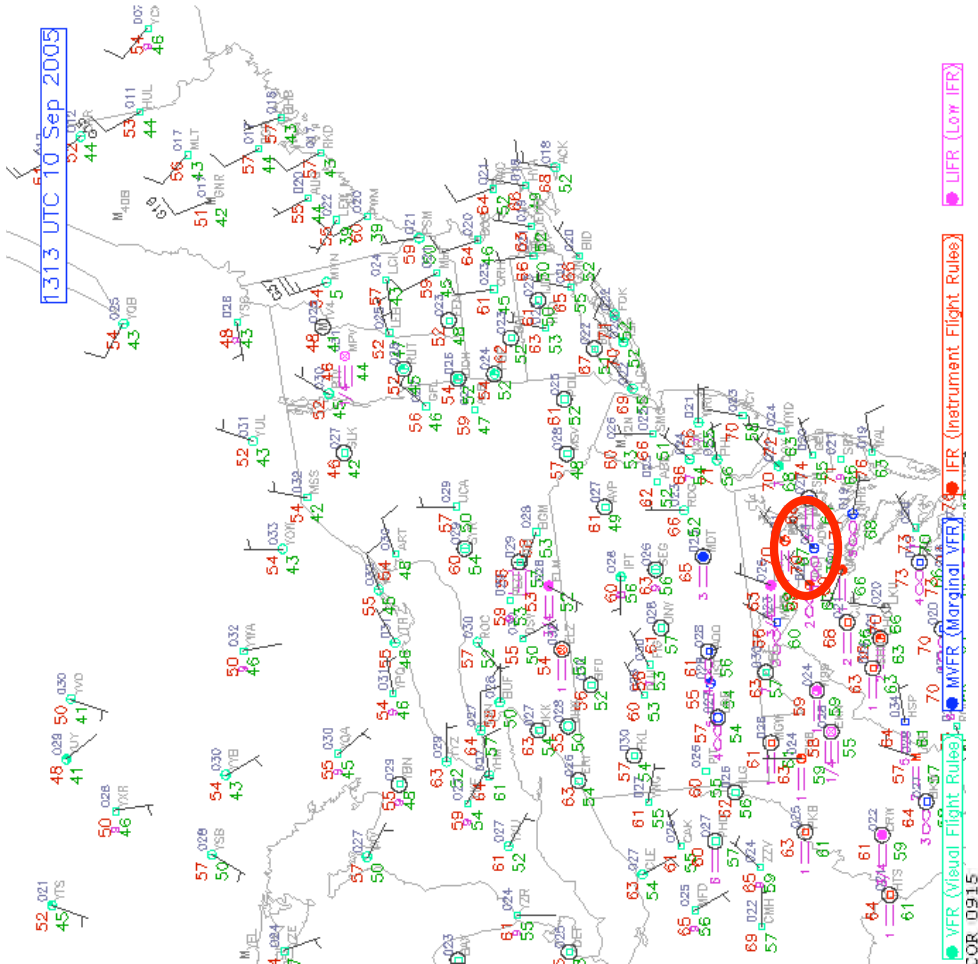
# METAR for the Andrew's AFB and surrounding area at approximately 1313 UTC on 10 September 2005.

## Broken clouds with ceiling at 030 for Andrews AFB. Winds from the east (080) at 6 kts.



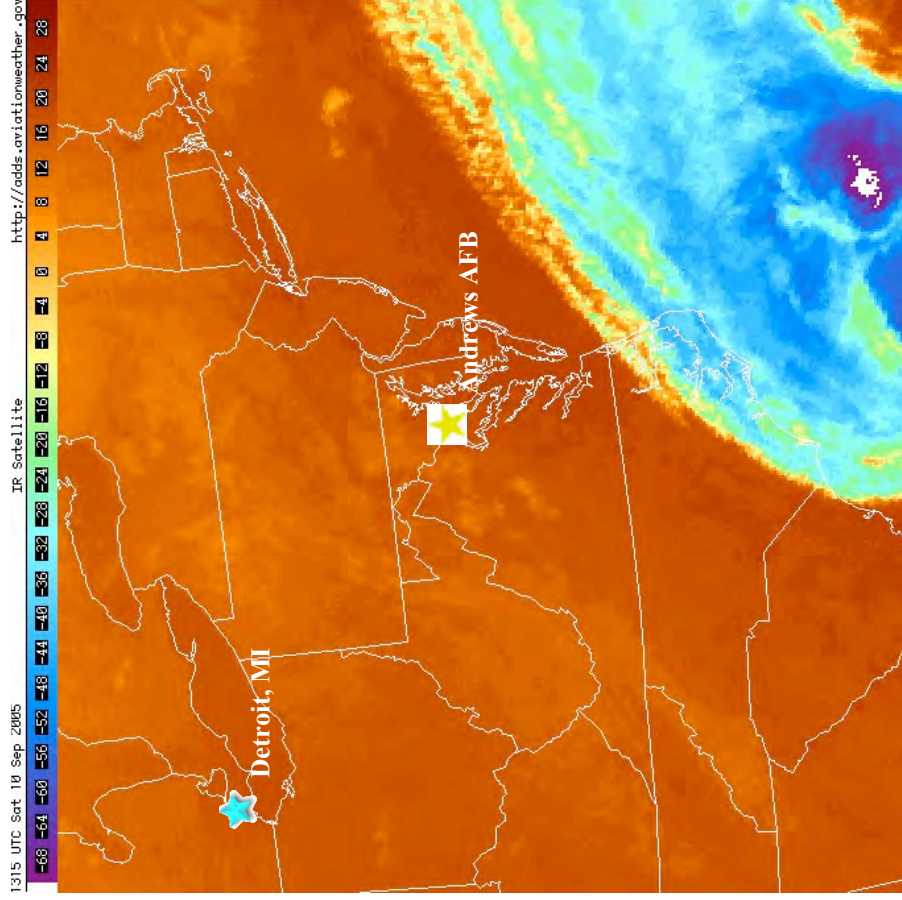
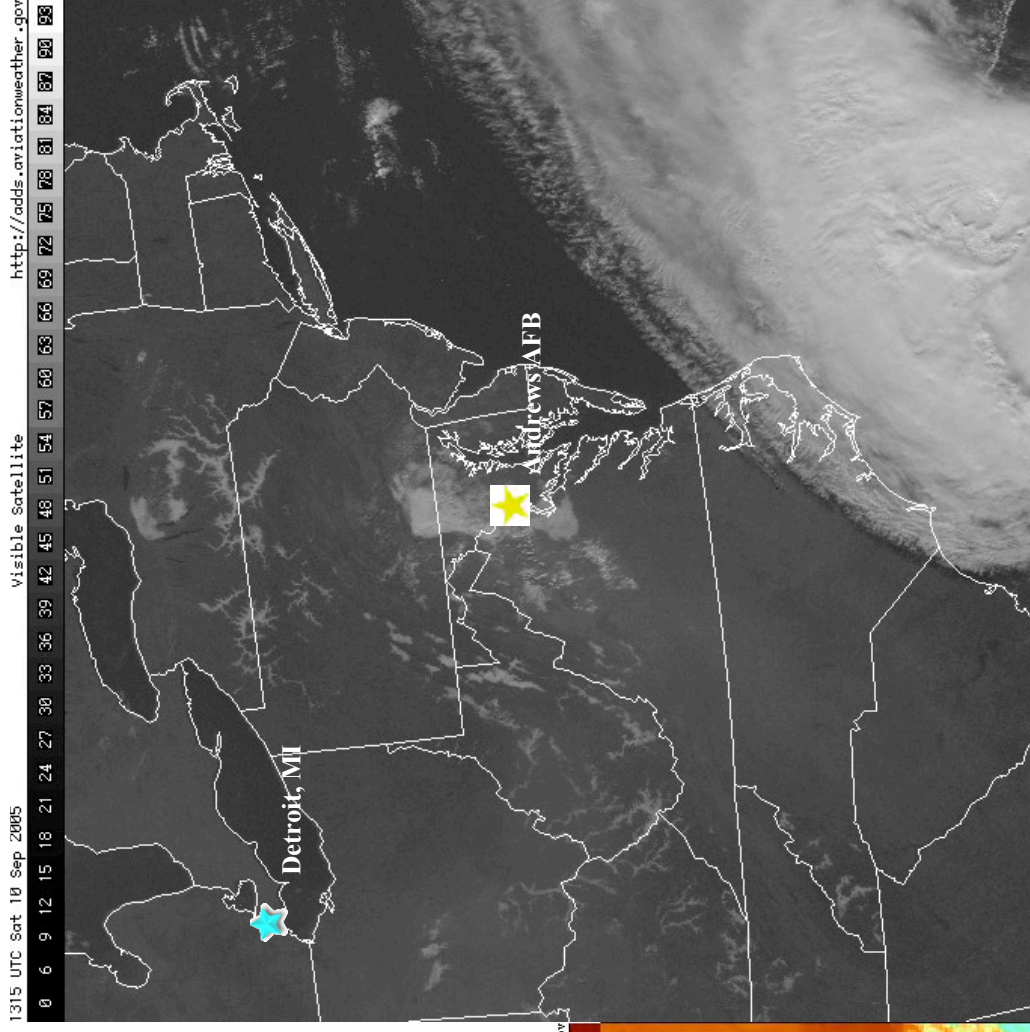
### Observations for ANDREWS, MD (ADW)

KADW 101552Z 08006KT 6SM HZ BKN030 27/18 A3022 RMK SLP236  
KADW 101552Z 08006KT 6SM HZ SCT030 25/18 A3022 RMK SLP236 51007  
KADW 101352Z 05004KT 5SM HZ SCT030 22/19 A3022 RMK SLP236  
KADW 101252Z 05004KT 5SM HZ FEW002 SCT070 21/04 A3021 RMK SLP233  
KADW 101241Z 03003KT 3SM BR SCT002 BKN070 20/06 A3021  
KADW 101222Z 02004KT 1SM RVRNO BR SCT002 BKN070 19/07 A3020  
KADW 101152Z 03004KT 1/4SM RVRNO FG SCT001 SCT002 BKN070 19/07 A3020  
KADW 101142Z 36002KT 3/16SM RVRNO FG SCT001 BKN002 18/07 A3018  
KADW 101145Z 02004KT 1/4SM RVRNO FG SCT001 SCT002 BKN070 19/07 A3020  
KADW 101052Z 02000KT 1/4SM R01/1600FT FG SCT002 BKN070 18/07 A3018 RMK SLP222  
KADW 101031Z 03002KT 1 3/4SM BR BKN065 18/08 A3017  
KADW 101048Z 02000KT 2SM BR BKN065 18/08 A3018  
KADW 100955Z COR 00000KT 2SM BR FEW002 BKN065 18/11 A3016 RMK SLP215 COR 1002  
KADW 100855Z COR VRB02KT 1SM R01/2800FT BR SCT002 17/16 A3014 RMK SLP208 53002 COR 0915  
KADW 100755Z 03002KT 2SM BR FEW000 18/17 A3013 RMK BR FEW000 SLP207  
KADW 100740Z COR 00000KT 2SM BR FEW000 18/17 A3013  
KADW 100652Z 00000KT 5SM HZ SKC 19/18 A3013 RMK SLP207  
KADW 100552Z 00000KT 5SM HZ SKC 18/17 A3013 RMK SLP207 53007  
KADW 100452Z COR 00000KT 5SM HZ SKC 18/17 A3013 RMK SLP203 COR 0502  
KADW 100352Z 00000KT 5SM HZ SKC 19/17 A3011 RMK SLP200  
KADW 100252Z 00000KT 5SM HZ SKC 19/18 A3011 RMK SLP200 51012  
KADW 100152Z 00000KT 7SM SKC 20/18 A3010 RMK SLP197  
KADW 100052Z 00000KT 7SM SKC 21/18 A3010 RMK SLP197  
KADW 092355Z 18002KT 7SM SKC 23/18 A3008 RMK SLP188 53012  
KADW 092255Z 12005KT 7SM FEW075 25/18 A3006 RMK SLP183  
KADW 092155Z 02009KT 7SM FEW050 SCT075 BKN250 28/16 A3004 RMK SLP176  
KADW 092055Z 01009KT 7SM FEW050 SCT075 BKN250 29/16 A3004 RMK SLP176 56008  
KADW 091955Z VRB04KT 7SM FEW150 OVC250 30/16 A3005 RMK SLP178  
KADW 091855Z VRB04KT 7SM FEW150 OVC250 30/16 A3006 RMK SLP181  
KADW 091755Z 06008KT 7SM FEW150 OVC250 29/15 A3007 RMK SLP185 58005  
KADW 091655Z 06006KT 7SM FEW150 OVC250 29/15 A3007 RMK SLP185  
KADW 091555Z 32002KT 7SM FEW150 OVC250 28/15 A3009 RMK SLP191  
KADW 091455Z 07000KT 7SM FEW150 OVC250 26/14 A3006 RMK SLP188 54006



Visible Satellite Imagery of the route of flight from Detroit to Andrews AFB at 1315 UTC on 10 September 2005

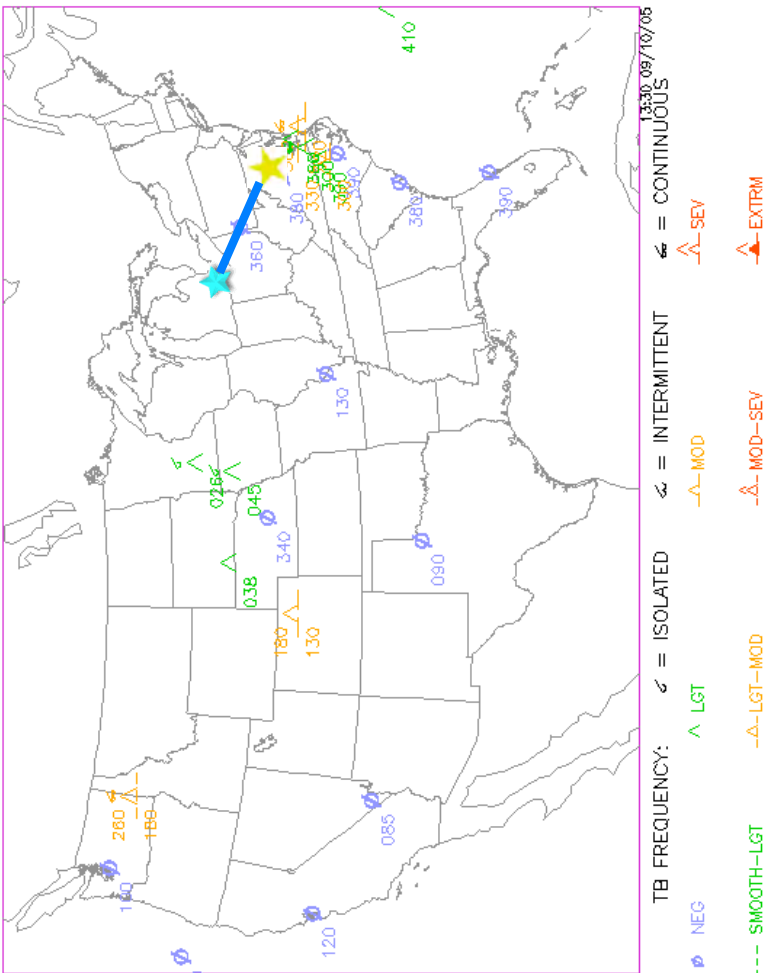
Both images show a disturbance in the area off of the Carolina coast. The pilot should be aware of this disturbance caused by Tropical Storm Ophelia in the Atlantic. Visible imagery indicates low clouds or fog in the area around Andrews AFB.



Infrared Imagery of the route of flight valid 1315 on 10 September 2005

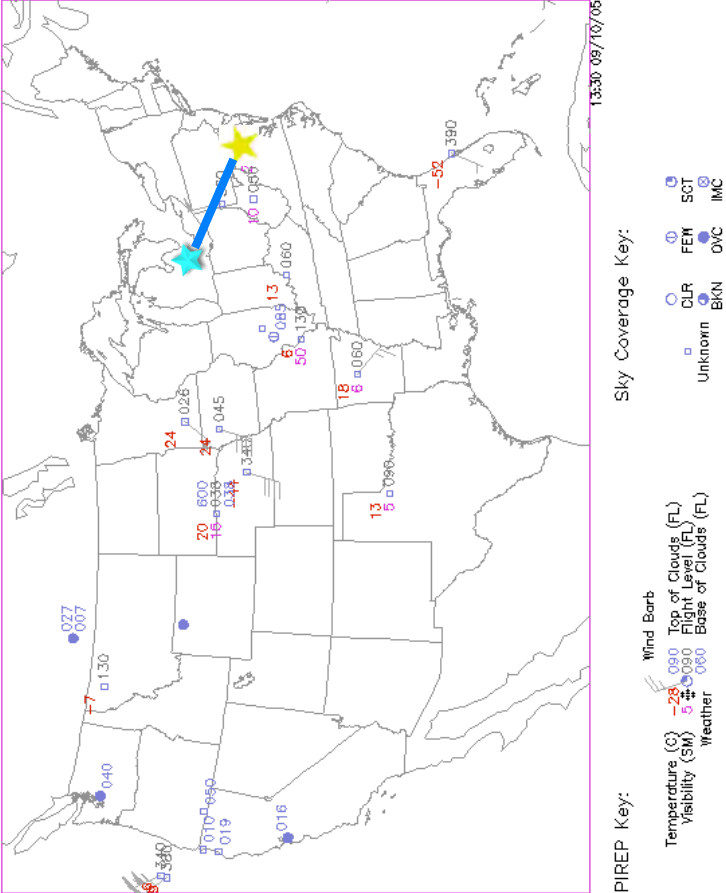
**PIREPs of Turbulence and  
Weather and Sky conditions  
valid until 1330 on 10  
September 2005:**

Pilot Reports (PIREPs) of Turbulence  
1202z - 1321z 09/10/05



**The Pilot should be aware there is light  
to moderate turbulence in the Andrews  
AFB area.**

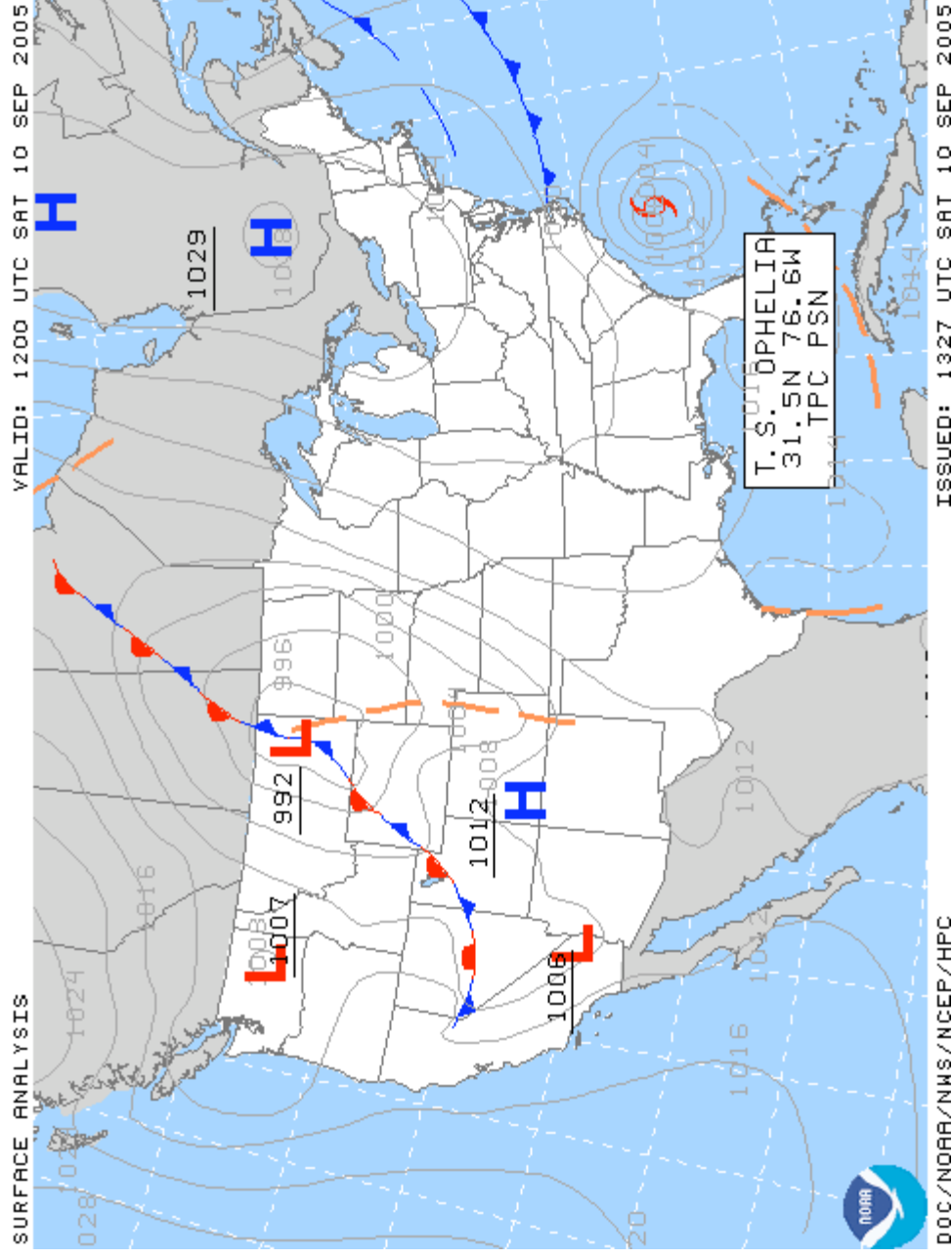
Pilot Reports (PIREPs) of Weather and Sky Conditions  
1158z - 1326z 09/10/05



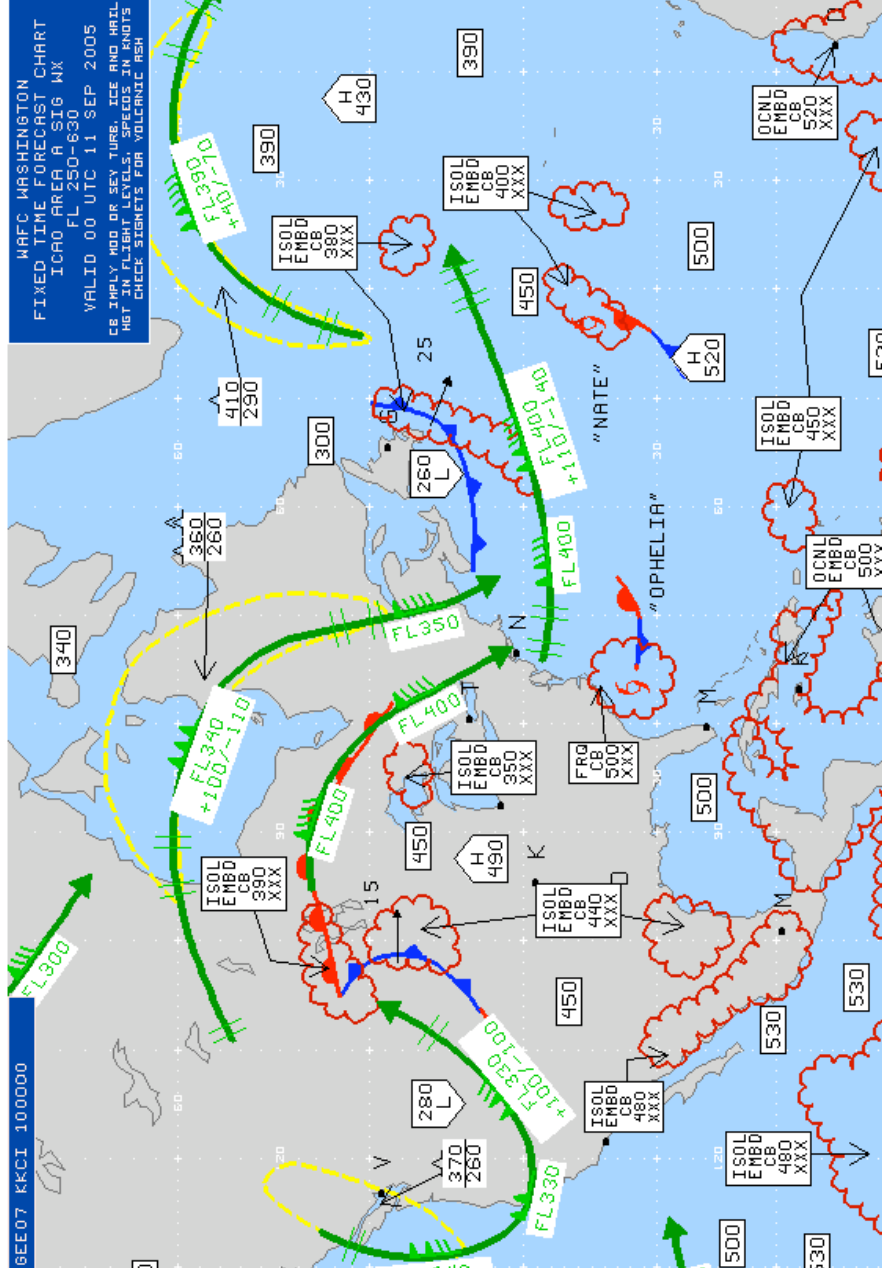
## Surface analysis valid 1200 UTC on 10 September 2005.

Map shows important divert/contingency management information for this leg of flight.

Map also shows the current location of Tropical Storm Ophelia.



# High-level fixed time forecast



# Reminder: Our Mission Objectives

The objectives of this mission are as follows:

- To depict the necessary weather data that must be accessible via a QICP weather provider to UAV pilots in order to conduct safe and successful missions
- To explain the knowledge that must be extrapolated from the weather data sources
- To show the complexity of forecasting weather for HALE missions
- To show potential contingency scenarios that may result from emergency situations
- To show the importance of weather to the overall success of the mission.

End of Flight Scenario

Any Questions?!

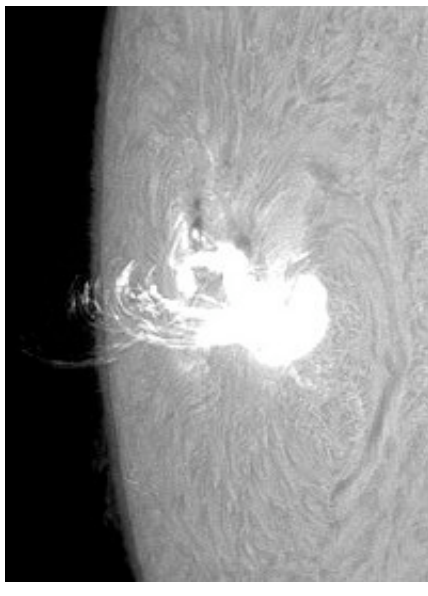


# Contingency Scenario

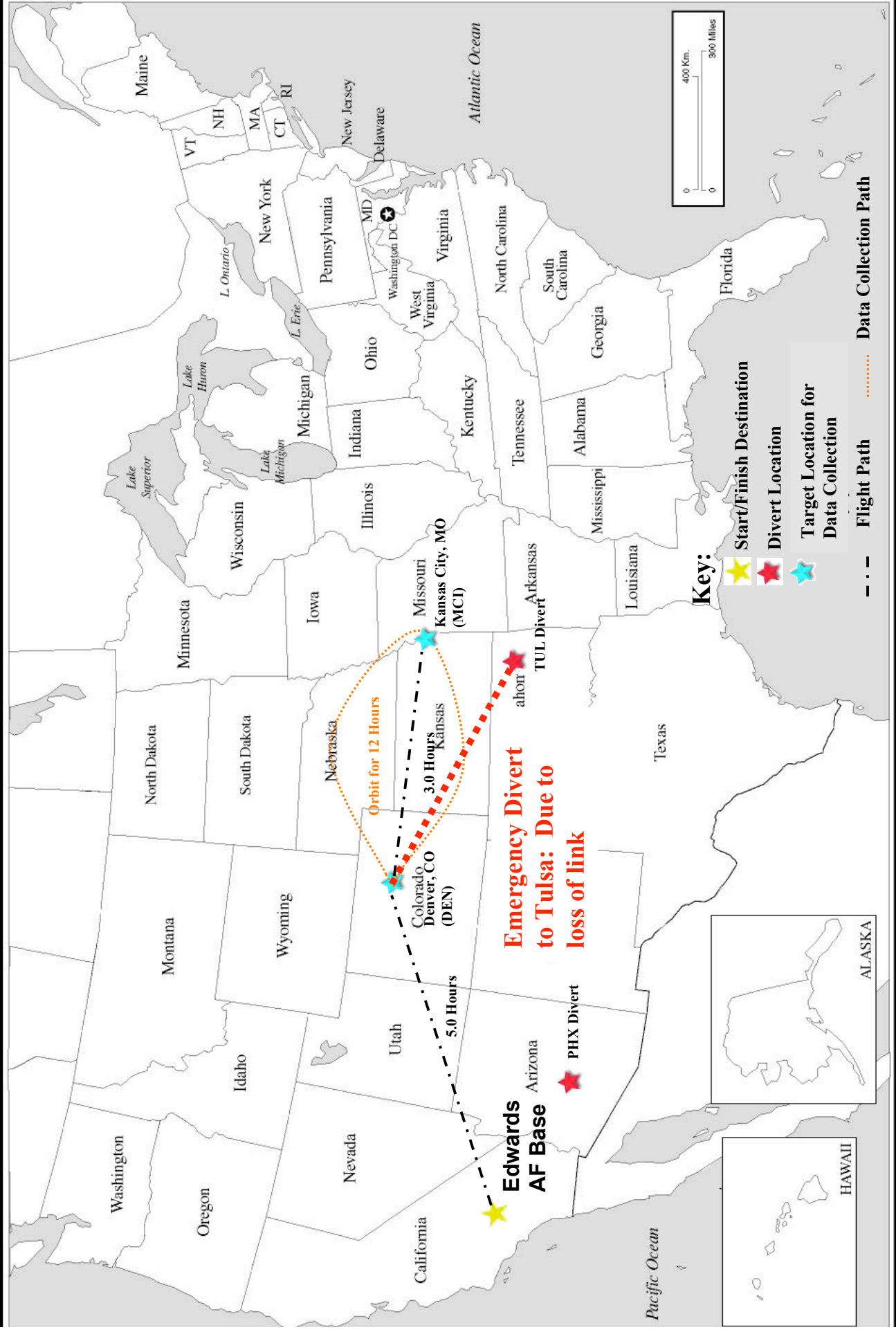


# Solar Weather Causes Loss of Link during Orbit One

- On September 7<sup>th</sup>, sunspot # 798/808 exploded, producing an X-17 solar flare. Explosions are expected to continue for the next few days.
- Each X-flare causes a shortwave radio blackout on Earth and pumped new energy into a radiation storm around our planet.
- Magnetic clouds are scheduled to hit the Earth on September 10<sup>th</sup> causing aurora's that are being seen as far south as Arizona.
- This solar activity has caused a loss of link on our UAV mid-orbit. The pilot should be aware of this activity and the plane is recommended to divert to the nearest divert point—in this section of flight the divert location is Tulsa, OK.
- In addition to solar activity, the METAR shows thunderstorms evolving in the Denver area accompanied with lightning.



# Access 5 Step One Flight Scenario Route



All active AIRMETs and SIGMETs  
chart created at 1255 UTC Fri 09 Sep 2005  
AIRMETs valid until 1400z/9th. SIGMETs expire at or before 1455z/9th

1259z - 1425z 09/09/05



1258z - 1426z 09/09/05



Unknown  
CLR  
BKN  
FEM  
OVC  
SCT  
IMC

Unknown  
CLR  
BKN  
FEM  
OVC  
SCT  
IMC

Wind Barb	Top of Clouds (FL)	Flight Level (FL)	Base of Clouds (FL)	Weather
	-28	090	050	SM

Unknown  
CLR  
BKN  
FEM  
OVC  
SCT  
IMC

chart created at 1255 UTC Fri 09 Sep 2005

AIRMETs valid until 1400z/9<sup>th</sup>, SIGMETs expire at or before 1455z/9<sup>th</sup>



VALID: 1200 UTC FRI 09 SEP 2005



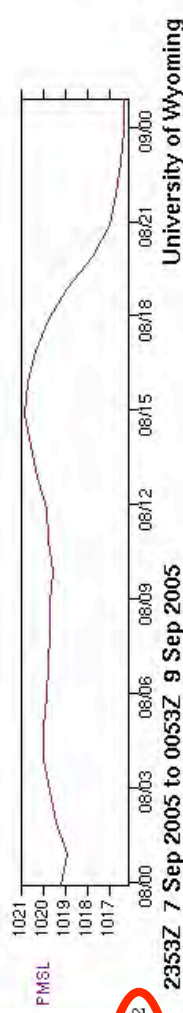
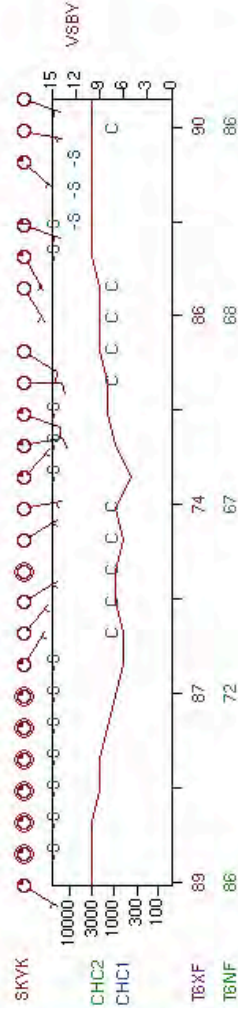
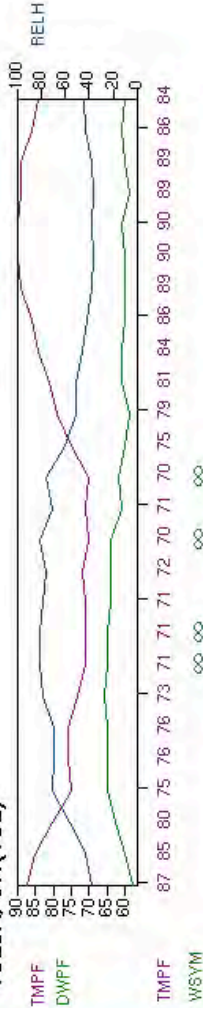
T.S. OPHELIA  
29.3N 79.1W  
ISSUED: 1341 UTC

# Divert to Tulsa, OK:

## Observations for TULSA, OK (TUL)

2353Z 7 Sep 2005 to 0053Z 9 Sep 2005

### TULSA, OK (TUL)



## Observations for TULSA, OK (TUL)

KTUL 090053Z 20004KT 10SM CLR 29/16 A3004 RMK AO2 SLP163 T02890156  
KTUL 082353Z 19007KT 10SM CLR 30/16 A3004 RMK AO2 SLP163 T03000161 103322  
KTUL 082253Z 22006KT 10SM FEW070 32/16 A3004 RMK AO2 SLP165 T03170156  
KTUL 082153Z 20006KT 10SM FEW070 32/15 A3005 RMK AO2 SLP167 T03170150  
KTUL 082053Z 20007KT 10SM FEW070 SCT200 32/16 A3006 RMK AO2 SLP170 T03220161 56026  
KTUL 081953Z 24007KT 10SM FEW200 32/16 A3008 RMK AO2 SLP178 T03220156  
KTUL 081853Z 24006KT 9SM CLR 32/16 A3011 RMK AO2 SLP189 T03170156  
KTUL 081753Z VRB05KT 9SM CLR 30/16 A3014 RMK AO2 SLP198 T03000156 10300 20200 58011  
KTUL 081653Z 21010KT 9SM CLR 29/16 A3016 RMK AO2 SLP204 T02890161  
KTUL 081553Z 18008KT 8SM CLR 27/16 A3017 RMK AO2 SLP207 T02720161  
KTUL 081453Z 20008KT 8SM FEW200 26/15 A3017 RMK AO2 SLP209 T02610150 51009  
KTUL 081353Z 17008KT 7SM FEW200 24/16 A3016 RMK AO2 SLP206 T02390156  
KTUL 081253Z 13003KT 5SM HZ FEW200 21/17 A3015 RMK AO2 SLP203 T02110167  
KTUL 081153Z 17005KT 7SM CLR 22/16 A3014 RMK AO2 SLP199 T02170161 10233 20194 53002  
KTUL 081053Z 15006KT 6SM HZ CLR 21/18 A3014 RMK AO2 SLP198 T02110178  
KTUL 080953Z 00000KT 7SM CLR 22/18 A3014 RMK AO2 SLP196 T02220178  
KTUL 080853Z 15003KT 7SM CLR 22/18 A3014 RMK AO2 SLP197 T02170178 56002  
KTUL 080753Z 13003KT 6SM HZ CLR 22/18 A3014 RMK AO2 SLP197 T02170183  
KTUL 080653Z 12003KT 6SM HZ FEW200 22/18 A3014 RMK AO2 SLP198 T02170183  
KTUL 080553Z 00000KT 7SM FEW200 23/19 A3014 RMK AO2 SLP199 T02280189 10306 20222 403170206 50002  
KTUL 080453Z 00000KT 8SM FEW200 24/18 A3015 RMK AO2 SLP200 T02440183  
KTUL 080353Z 00000KT 9SM FEW200 24/18 A3015 RMK AO2 SLP200 T02440183  
KTUL 080253Z 00000KT 9SM FEW200 24/18 A3014 RMK AO2 SLP197 T02390183 53005  
KTUL 080153Z 00000KT 10SM FEW200 27/17 A3013 RMK AO2 SLP194 T02670172  
KTUL 080053Z 00000KT 10SM FEW200 29/16 A3011 RMK AO2 SLP189 T02940156  
KTUL 072353Z 21004KT 10SM FEW200 31/14 A3012 RMK AO2 SLP192 T03060144 10317 20300 56011

Forecast for: KTUL

Text:

KTUL 231727Z 231818 18007KT P6SM SCT250

Forecast period: 1800 UTC 23 September 2005 to 0400 UTC 24 September 2005

Forecast type: FROM: standard forecast or significant change

Winds: from the S (180 degrees) at 8 MPH (7 knots; 3.6 m/s)

Visibility: 6 miles (10 km)

Clouds: scattered clouds at 25000 feet AGL

Weather: no significant weather forecast for this period

## TAF for Tulsa, Oklahoma

**NOTE: Specific TAFs related to the contingency scenario were not included in the original presentation. TAFs were included here to verify availability over the public internet Aviation Digital Data Service (ADDS) site.**

## TAF for Andrews Air Force Base

Forecast for: KADW

Text:

KADW 231717 34012KT 9999 SCT100 SCT250 QNH2994INS

Forecast period: 1700 to 2000 UTC 23 September 2005

Forecast type: FROM: standard forecast or significant change

Winds: from the NNW (340 degrees) at 14 MPH (12 knots; 6.2 m/s)

Visibility: 6 or more miles (10+ km)

Clouds: scattered clouds at 10000 feet AGL

scattered clouds at 25000 feet AGL

Weather: no significant weather forecast for this period

## TAF for Denver, Colorado

Forecast for: KDEN

KDEN 231722Z 231818 VRB05KT P6SM FEW080  
SCT140 SCT250

1800 to 2000 UTC 23 September 2005

FROM: standard forecast or significant change

Forecast type:

Winds: variable direction winds at 6 MPH (5 knots; 2.6 m/s)

Visibility: 6 miles (10 km)

Clouds: few clouds at 8000 feet AGL

scattered clouds at 14000 feet AGL

scattered clouds at 25000 feet AGL

Weather: no significant weather forecast for this period